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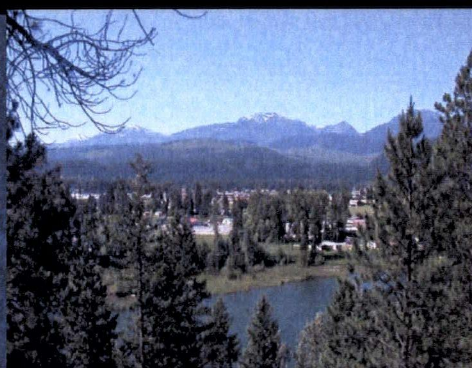
FINAL Remedial Investigation Report

Libby, Montana

Operable Unit 5
Libby Asbestos National Priorities List Site



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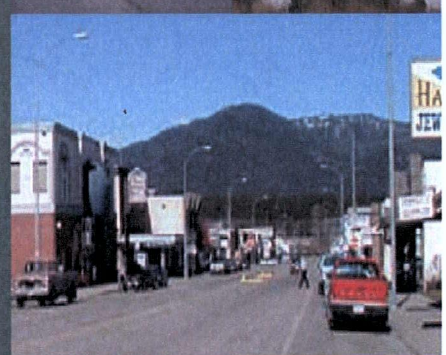

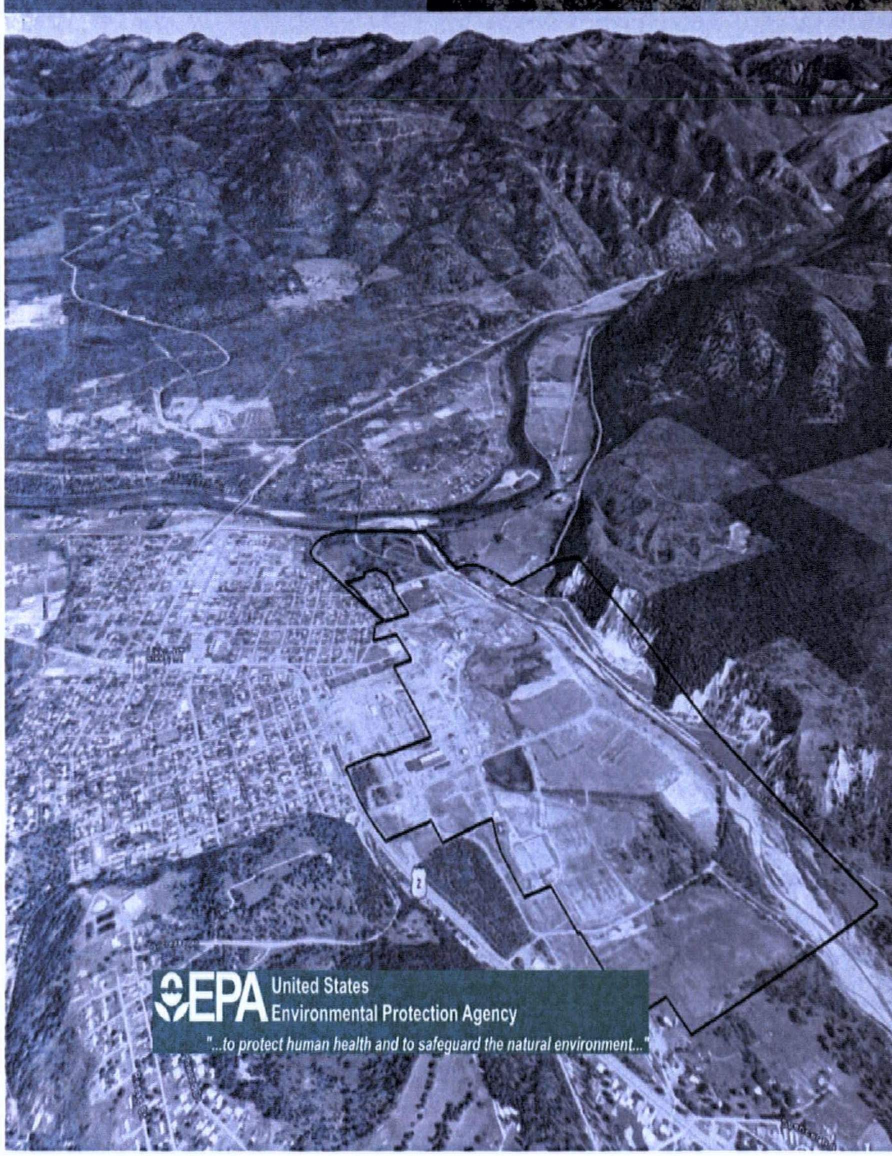

EPA United States Environmental Protection Agency

"...to protect human health and to safeguard the natural environment..."

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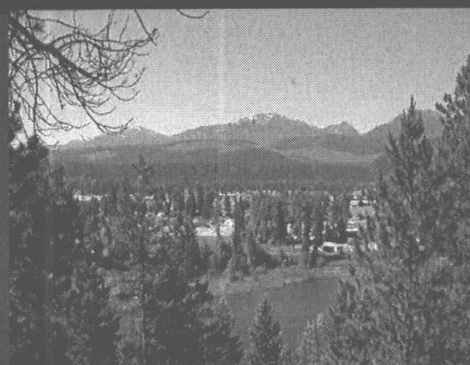

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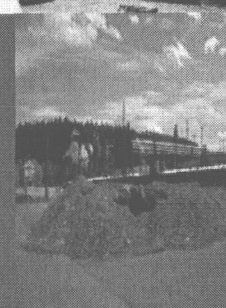

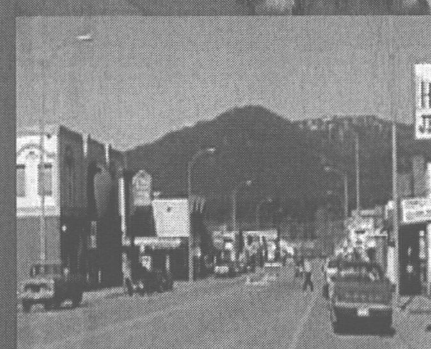

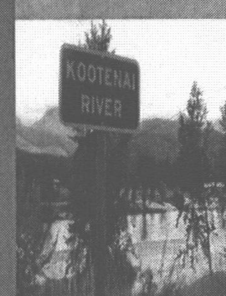

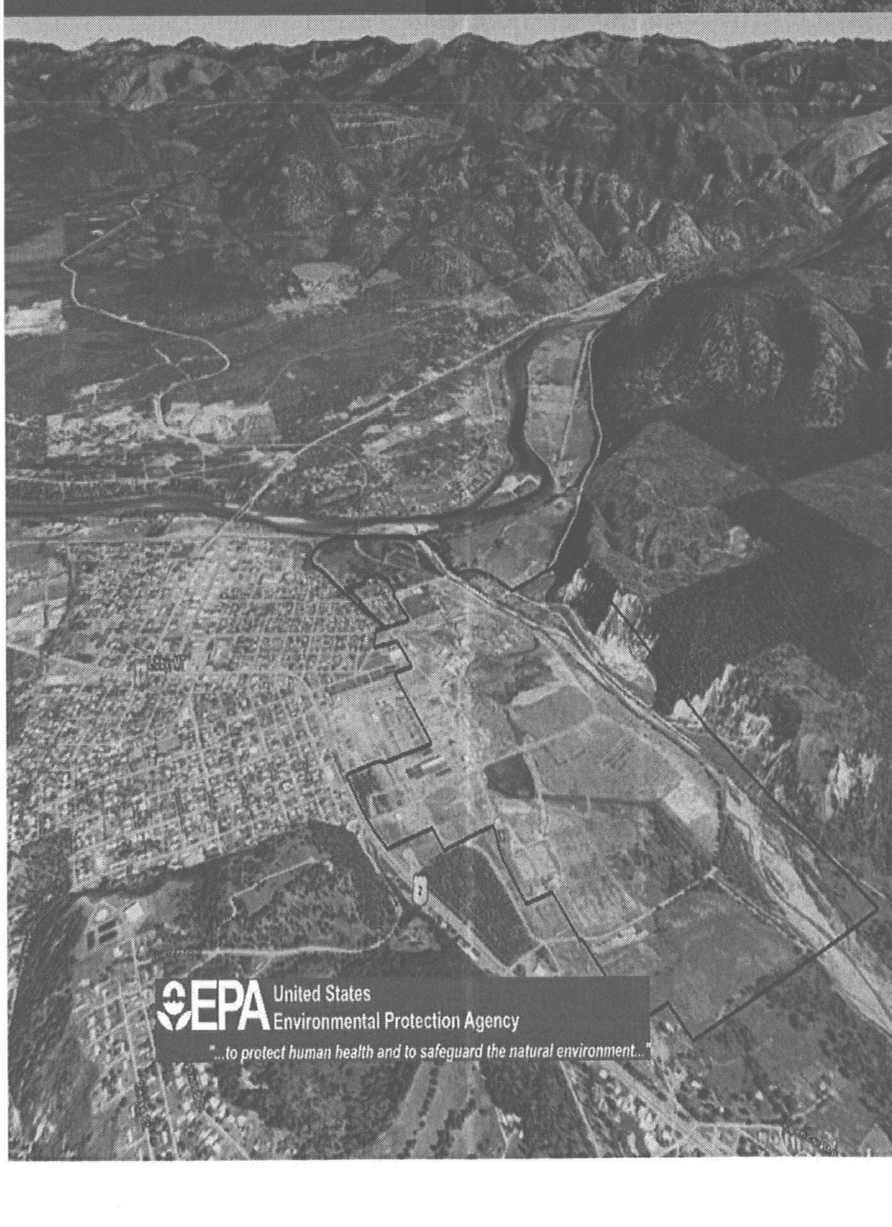

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FINAL
Remedial Investigation Report

Operable Unit 5
Libby Asbestos National Priorities List Site
Libby, Montana

June
2013

Prepared for
US Environmental Protection Agency

by

HDR Engineering, Inc.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

A – Response Action Reports

A1 – OU5 Redevelopment Area Investigation Summary

A2 – Response Actions at Central Maintenance Building

A3 – Libby and Troy Creek Investigation Summary Memo

A4 – Completion Form for a Quick Response at the Plywood Plant.

A5 – Completion Form for a Quick Response at the Valve House at Stimson Finger-Joiner Building

A6 – Completion Form for a Quick Response at the Former Popping Plant on OU5.

A7 – Completion Form for a Quick Response at the Lincoln County Port Authority Property (CDM Offices).

A8 – Documentation of Soil Removal Activities at the Former Tree Nursery

B – Sample Phase List

C – Asbestos Analysis Methods and Data Reduction Techniques

D – Analytical and Other Data

D1 – Scribe Database

D2 – Scribe Queries

E – Data Quality Assessment

F – Supplemental Investigation Reports

F1 – Wood Chip ABS

F2 – Proposed Fishing Pond Pre-design Investigation (at Former Tree Nursery)

LIST OF ACRONYMS

ABS	Activity-Based Sampling
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
DQA	Data Quality Assessment
DQOs	Data quality objectives
EDDs	Electronic data deliverables
EPA	U.S. Environmental Protection Agency
ERT	Emergency Response Team
FS	Feasibility Study
FSDS	Field sample data sheet
ft	Foot
GPS	Global Positioning System
ISO	International Organization for Standardization
KBPID	Kootenai Business Park Industrial District
LA	Libby Amphibole
LG Site	Libby Groundwater Superfund Site
Libby2DB	Libby 2 Database
mg/m^3	milligrams per cubic meter
msl	mean sea level
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
OUs	Operable Units
PAH	Polycyclic aromatic hydrocarbons
PCM	Phase Contrast Microscopy
PCME	Phase Contrast Microscopy Equivalent
PCP	Pentachlorophenol
PLM	Polarized light microscopy
PLM-VE	Polarized Light Microscopy – Visual Estimation
PRP	Potentially responsible parties
RI	Remedial Investigation
ROD	Record of Decision
s/cc	Structures per cubic centimeter
s/cm^2	Structures per square centimeter
SAP	Sampling and Analysis Plan
SOPs	Standard operating procedures
SQL	Structured query language
TEM	Transmission electron microscopy
µm	micrometer

EXECUTIVE SUMMARY

Overview

This Remedial Investigation (RI) Report describes the nature and extent of Libby amphibole (LA) asbestos at Operable Unit 5 (OU5) of the Libby Asbestos National Priority List (NPL) Site (the Site) located in Lincoln County, Montana. LA occurrence throughout the Site resulted from long time mining activities.

Operable Unit 5 is also referred to as the former Stimson Lumber Mill site, as many lumber processing facilities were located throughout OU5. The majority of lumber production activities ceased in 2003 when Stimson Lumber Company sold the property to the Lincoln County Port Authority and ownership was subsequently transferred to the current owner, Kootenai Business Park Industrial District (KBPID). The OU5 site is currently being redeveloped for a variety of uses, both recreational and industrial. Major site features and land uses are illustrated on Figure ES-1.

Gold miners discovered vermiculite in Libby in 1881; in the 1920s the Zonolite Company formed and began mining the vermiculite. In 1963, W.R. Grace bought the Zonolite mining operations which closed in 1990. While in operation, the Libby mine may have produced 80 percent of the world's supply of vermiculite. Vermiculite has been used in building insulation and as a soil conditioner.

Vermiculite often contained asbestos and therefore, vermiculite mining, processing, and shipping acted as a carrier to spread asbestos throughout Libby. Raw vermiculite ore was estimated to contain up to 26% LA.

Asbestos found at the Libby Site contains a variety of different amphibole types. Amphibole is the name of an important group of generally dark-colored minerals, forming prism or needlelike crystals. Because there are presently insufficient toxicological data to distinguish between the different forms of amphibole asbestos, the Environmental Protection Agency (EPA) evaluates all of the mine-related amphibole asbestos types together (referred to as LA). Asbestos exposure in humans may cause both cancer and non-cancer effects. Among them are:

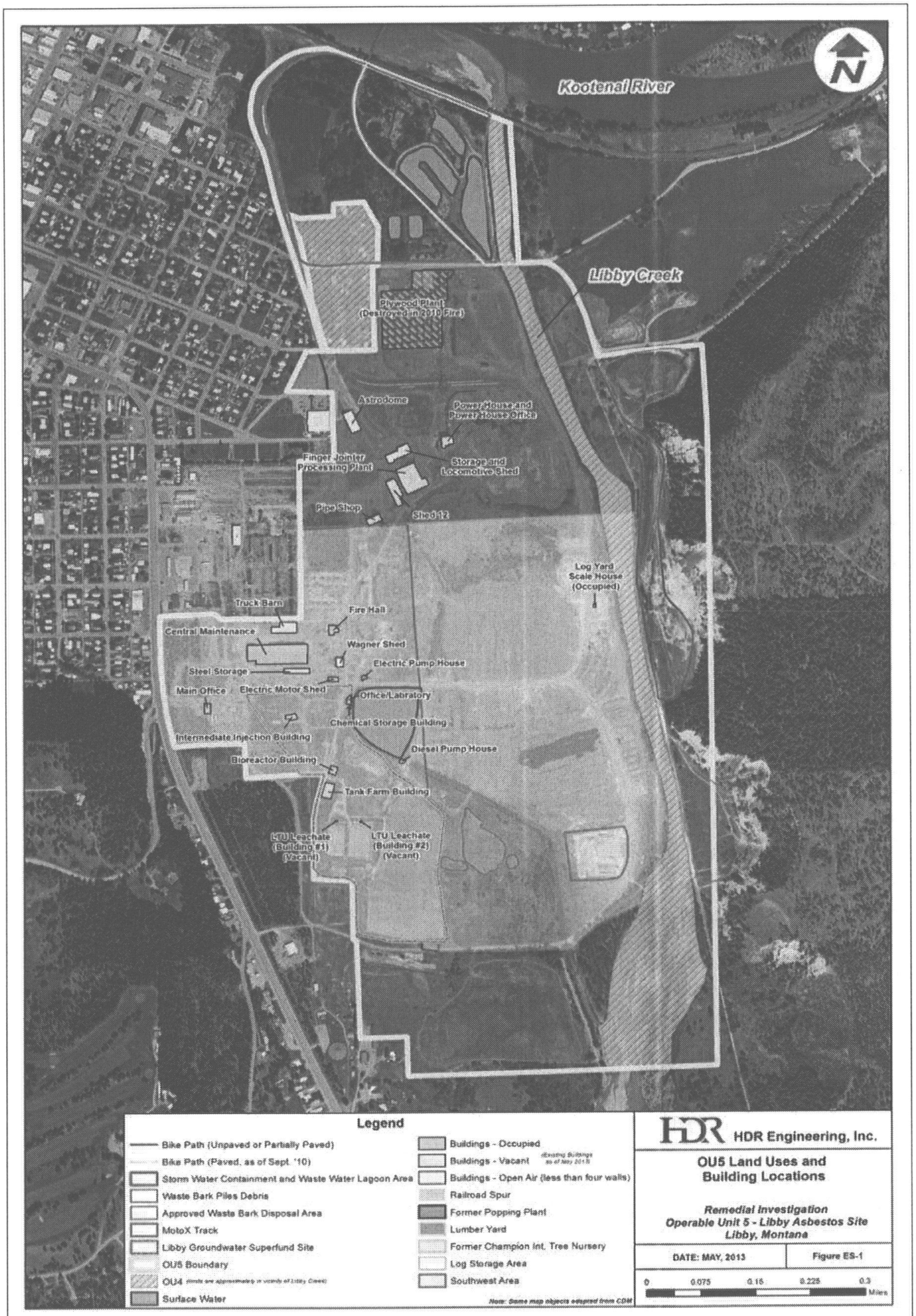
Non-Cancer Effects:

- Asbestosis
- Pleural Abnormalities

Cancer Effects:

- Lung cancer
- Mesothelioma

People who visit or work at OU5 may be exposed to LA by incidental ingestion of contaminated soil or dust and by inhalation of air that contains LA fibers. Of these two pathways, inhalation exposure is considered to be of greater concern as it is most often associated with disease of the respiratory system.



N
Kootenai River
Libby Creek
Plywood Plant (Destroyed in 2010 Fire)
Astrodome
Power House and Power House Office
Finger Jointer Processing Plant
Storage and Locomotive Shed
Pipe Shop
Shed 12
Log Yard Scale House (Occupied)
Truck Barn
Fire Hall
Central Maintenance
Wagner Shed
Steel Storage
Electric Pump House
Main Office
Electric Motor Shed
Office/Labratory
Chemical Storage Building
Intermediate Injection Building
Diesel Pump House
Bioreactor Building
Tank Farm Building
LTU Leachate (Building #1) (Vacant)
LTU Leachate (Building #2) (Vacant)
Legend
Bike Path (Unpaved or Partially Paved)
Bike Path (Paved, as of Sept. '10)
Storm Water Containment and Waste Water Lagoon Area
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MotoX Track
Libby Groundwater Superfund Site
OU5 Boundary
OU4
Surface Water
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Buildings - Open Air (less than four walls)
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Lumber Yard
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Log Storage Area
Southwest Area
HDR Engineering, Inc.
OU5 Land Uses and Building Locations
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: MAY, 2013
Figure ES-1
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0.225
0.3
Miles

Asbestos fibers can be released into the air due to disturbance of asbestos containing environmental media such as soil. The amount of LA fibers released to air will vary depending upon the level of LA in the source material and the intensity and duration of the disturbance activity. Because of this, predicting LA levels in air associated with disturbance activities based only on measured LA levels in source material is extremely difficult. Therefore, the most direct way to determine potential exposures from inhalation is to measure, through sample and analysis, the concentration of LA in air during a specific activity that disturbs a source material. For convenience, this is referred to as activity-based sampling (ABS).

Site Investigations

Investigations at OU5 began in May of 2002 and continued through 2012. EPA performed several ABS studies at in 2007 and 2008 to investigate levels of LA in air associated with a variety of activities under current conditions. In addition to the ABS studies, the following additional media-specific sampling was conducted:

- Dust - standing dust samples collected from horizontal surfaces inside buildings.
- Soils
    - Surface – composite and grab samples collected from 0 to 6 inches below ground surface (bgs).
    - Sub-surface – composite and grab samples collected 6 or more inches bgs.
- Waste Bark - material samples from an existing waste pile.

ABS from most occupied buildings contained detectable levels of LA. For buildings where LA was detected, the mean concentration varied by a factor of 1,000. LA was detected in seven of the eight outdoor worker ABS areas. The mean LA concentration varied by a factor of 10 across the seven areas where LA was detected. Sampling at the MotoX area included stationary samplers proximal to the location of spectators as well as samplers fixed to the handlebars of dirt bikes. No LA fibers were detected in any air sample.

ABS was conducted separately for paved and unpaved portions of the bike path. On the paved path, a stationary air monitor was also mounted in a trailer attachment to one of the bicycles to characterize potential exposures to a young child being pulled by a parent. Mean LA concentrations for the adult and child are similar.

Of the 87 indoor dust field samples collected, 28 samples had detectable levels of LA. Only four samples had levels of LA above the current EPA removal action level for indoor dust (> 5,000 total LA structures per square centimeter).

Soil samples were examined both visually for vermiculite and by polarized light microscopy (PLM). PLM results are generally non-detect or trace across OU5. The one location where PLM results have consistently been higher (with observed LA levels up to 1%) is the north-central portion of the former Tree Nursery area (Figure ES-1). This location also has elevated visible vermiculite scores.

Of the 19 waste bark samples analyzed, LA was detected in 1 sample analyzed by PLM and 13 samples analyzed by transmission electron microscopy. These results indicate that LA is present but it is not possible to quantify how much LA may be present based on this qualitative method.

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An evaluation of potential exposures to and risks from LA will be included in the site-wide risk assessments for the Libby Asbestos Superfund Site. Site-wide risk assessments are stand-alone documents which support the feasibility study and record of decision (ROD).

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Asbestos found at the Libby mine contains a variety of different amphibole types. Because there are presently insufficient toxicological data to distinguish between the different forms, the Environmental Protection Agency (EPA) evaluates all of the mine-related amphibole asbestos types together. This mixture is referred to as LA. Most of the mining operations in Libby were not focused on asbestos, as it was not particularly valuable. However, vermiculite, the main ore extracted and processed at the mine, often contained asbestos and therefore, vermiculite mining acted as a carrier to spread asbestos throughout Libby. Raw vermiculite ore was estimated to contain up to 26% LA (Midwest Research Institute, 1982).

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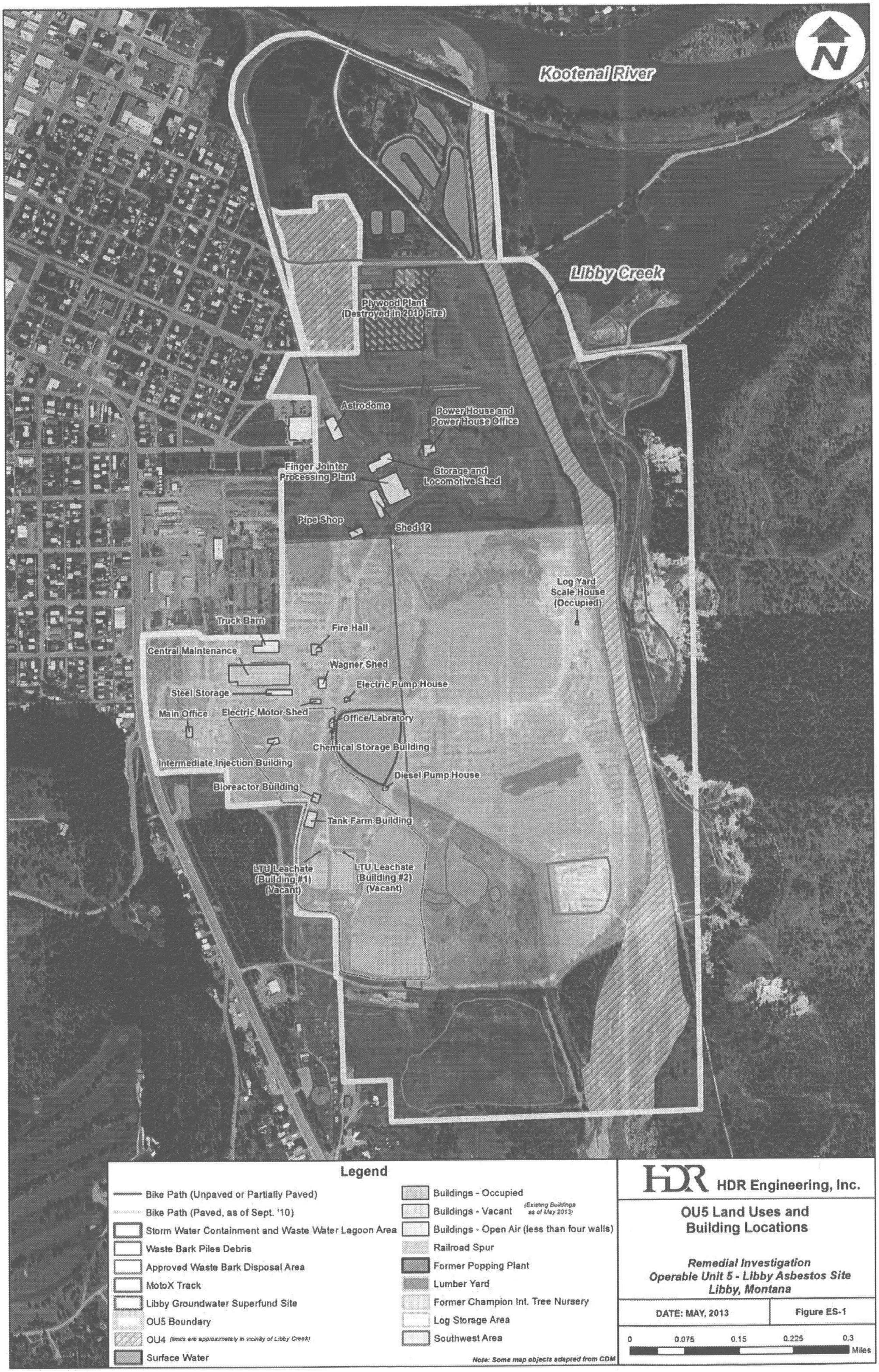

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1.0 INTRODUCTION

1.1 OVERVIEW AND REPORT ORGANIZATION

This Remedial Investigation (RI) Report describes the nature and extent of Libby amphibole (LA) asbestos and associated human health risks at Operable Unit 5 (OU5) of the Libby Asbestos National Priority List (NPL) Site (the Site). LA occurrence throughout the Site resulted from long time mining activities and the use and handling of materials which contained LA.

U.S. Environmental Protection Agency (EPA) has had a presence in Libby since 1999 and has completed a number of sampling activities and removal efforts. EPA determined there was imminent and substantial endangerment to public health from asbestos contamination in various types of source materials in and around Libby.

In light of evidence of human asbestos exposure and associated increase in health risks, it was recommended that EPA take appropriate steps to reduce or eliminate exposure pathways to these materials to protect area residents and workers. In 2002, Libby was classified as a NPL Site which, due to its large size, has been divided into eight Operable Units (OUs):

- OU1 – Former Export Plant
- OU2 – Former Screening Plant
- OU3 – Mine Site
- OU4 – Residential and commercial properties in and around Libby
- OU5 – Former Stimson Lumber Mill
- OU6 – Rail Line
- OU7 – Residential and commercial properties in and around Troy
- OU8 – US and Montana State highways and secondary highways in the vicinity of Libby and Troy, Montana.

Figure 1-1 presents a map showing the entire NPL area and boundaries of all OUs. This RI addresses OU5, which is located south of the incorporated limits of Libby and contains the former Stimson Lumber Mill and all properties owned by Kootenai Business Park Industrial District (KBPID). The OU5 boundary also encompasses the unrelated Libby Groundwater Superfund Site (LG Site), which has been on the NPL since September 1983 due to groundwater contamination resulting from wood preservative processing (Figure 1-2). While the LG Site is separate from LA investigations described in this RI, the land surface within the LG Site was sampled as part of the OU5 investigation. In addition, air samples were taken at buildings within the LG Site.

Libby Creek (which is part of OU4) traverses the western portion of OU5, but is not part of OU5. Therefore, it will not be discussed in this report.

The RI Report is organized into the following major sections:

Section 1 – Introduction – This section describes the purpose of the RI and summarizes prior work and NPL Site history.

Section 2 – Site Characteristics – This section provides a brief description of Site setting, climate, geology, hydrogeology, and surface water hydrology.

Section 3 – Sampling and Analyses – This section discusses sample types and collection methods and analytical techniques.

Section 4 – Data Recording, Data Quality Assessment, and Data Selection – This section discusses the Libby database, quality control measures and how data were selected to produce the final OU5 data set used to describe the nature and extent of contamination and for calculation of health risk estimates.

Section 5 – Nature and Extent of Contamination – This section provides a description of the current type and extent of LA in surface and subsurface soils, indoor and outdoor air and bulk materials. In addition, a brief discussion of groundwater conditions is provided associated with the LG Site underlying portions of OU5.

Section 6 – Contaminant Fate and Transport – This section provides a qualitative discussion of LA contaminant migration routes and persistence in the environment.

Section 7 – Baseline Risk Assessment – This section discusses the human health and ecological risk assessment.

Section 8 – Conclusions – This section presents general conclusions.

Section 9 – References – This section provides full references for all citations in the body of the report.

1.2 NPL SITE LOCATION & TOPOGRAPHY

The City of Libby, Montana is located in the northwest corner of the state, 35 miles east of Idaho and 65 miles south of the Canadian border (Figure 1-1). It is at an elevation of approximately 2,580 feet (ft) above mean sea level (msl). The source of LA, Vermiculite Mountain, is located approximately 7 miles northwest of Libby. The city has a total area of 1.3 square miles and lies in a valley carved by the Kootenai River and bounded by the Cabinet Mountains to the south.

The OU5 site is relatively flat and slopes slightly towards the north north-east. It encompasses approximately 400 acres and includes a number of commercial and industrial buildings as well as areas used for recreation.

1.3 NPL SITE HISTORY

Libby is located near a large open-pit vermiculite mine on Vermiculite Mountain. Vermiculite is mica-like mineral that can be processed for use as an insulating material or soil amendment and has been mined in Libby since 1919. It is estimated that the Libby mine was the source of over 70 percent of all vermiculite sold in the U.S. from 1919 to 1990. Over its lifetime, it employed more than 1,900 people. W. R. Grace bought the mine and processing facility in 1963 and operated it until 1990 (EPA, 2010a)

Vermiculite from this mine contains varying levels of amphibole asbestos, consisting primarily of winchite and richterite, with lower levels of tremolite, magnesioriebeckite, and possibly actinolite. Because existing toxicological data are not sufficient to distinguish differences in toxicity among these different forms, EPA does not believe that it is important to attempt to distinguish among these various amphibole types. Therefore, EPA simply refers to the mixture as Libby amphibole (LA) asbestos. Historic mining, milling, and processing operations as well as bulk transfer of mining-related materials, tailings, and waste to locations throughout Libby Valley, are known to have resulted in releases of vermiculite and LA to the environment. This has caused a range of adverse health effects in exposed people, including individuals who did not work at the mine or processing facilities

EPA has been working in Libby since 1999 when an Emergency Response Team (ERT) was sent to investigate local concern and news articles about asbestos-contaminated vermiculite. Since that time, EPA has been working closely with the community to clean up contamination and reduce risks to human health.

Based on health risks associated with asbestos, which include asbestosis, lung cancer and mesothelioma, EPA placed the Libby Asbestos Site on the NPL in October 2002.

Libby, Montana, which is the Lincoln County seat, has a population of less than 3,000, and 12,000 people live within a ten-mile radius. While Libby's economy is still largely supported by natural resources such as logging and mining, there are also many tourist and recreational opportunities in the area.

1.4 OU5 HISTORY AND DESCRIPTION

Operable Unit 5 is also referred to as the former Stimson Lumber Mill site, as many lumber processing facilities were located throughout. The J. Neils Lumber Company began wood treating operations at OU5 in approximately 1946. The lumber company and wood treating operation was purchased by St. Regis Corporation in 1957. Champion International Corporation purchased the facility in 1985 who then sold it to Stimson Lumber Company in 1993.

The majority of lumber production activities ceased in 2003 when Stimson Lumber Company sold the property to the Lincoln County Port Authority and ownership was subsequently transferred to the current owner, KBPID. The Site is currently being redeveloped for a variety of uses, both recreational and industrial.

Figure 1-3 shows former and current land uses and buildings throughout the Site that existed in June 2010. One of the largest structures at OU5, the Plywood Plant, was entirely destroyed by fire in early 2010.

During Site interviews conducted in 2001, three specific outdoor subareas of interest were identified (CDM, 2007a) due to potential vermiculite (and associated LA) contamination concerns (Figure 1-3):

- The former Popping Plant was once used as an aboveground storage area for uncontained vermiculite ore. Ore was stockpiled directly on the native soil surface in this area.
- The Railroad Spur was used for shipping raw and unprocessed vermiculite material to and from OU5.
- The former Tree Nursery may have introduced raw vermiculite product into this area as a growth medium and fill material.

Additionally, waste bark piles remain from historical lumber processing activities at OU5.

Under current conditions, OU5 is used mainly for commercial/industrial purposes. Portions of the Site are used for recreational purposes. This includes an area that has been developed as a Moto-Cross (MotoX) Park for dirt biking riding, and a trail along Libby Creek that is popular for hiking and bicycle riding. Most of these features are illustrated on Figure 1-3.

Currently, there is no residential land use on OU5. However, a residential area (part of OU4) lies within the OU5 boundaries as shown on Figure 1-3. In addition, residential neighborhoods surround OU5 to the west and northwest.

Redevelopment plans are currently being formulated for OU5. The Kootenai River Development Counsel was awarded a grant to upgrade the rail lines and electrical system throughout the Site. Plans have also been developed for a walking path and fishing pond.

Limited tree and grass plant species are located within OU5, primarily along the northern boundary and surrounding Libby Creek. The majority of OU5 is un-vegetated and suitable for industrial/commercial development.

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Explain what a plant popping is.

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1.5 REGULATORY HISTORY

The following is a brief chronological summary of major regulatory actions taken at the Site.

- 1999 – Local concern alerts EPA to investigate asbestos in and around Libby, Montana
- 2002 – Libby Asbestos Site proposed for the NPL
- 2002 – Libby Asbestos Site formally added to the NPL
- 1999 through 2013 – Response actions taken to remove asbestos and vermiculite containing material throughout OU5 (Table 1-1)

EPA has not entered into any enforcement agreements or issued any orders for investigation, removal, or remedial work at any part of OU5. The Stimson Lumber Company removed some loose and accessible vermiculite insulation in 2002 and 2003. EPA contractors have taken samples at OU5 many times beginning in 2002. EPA removed vermiculite insulation from a portion of the roof and walls at the Central Maintenance Building in 2005 and contamination from surface soils several times since 2009. None of these actions was pursuant to any enforcement agreement or order. EPA entered into a site wide settlement with the only Potentially Responsible Party (PRP) for OU5, W. R. Grace, in 2008. That agreement provided for a cash settlement of past and future response costs for the entire Libby NPL Site except OU3, the mine site.

1.6 PREVIOUS RESPONSE ACTIONS AT OU5

EPA established a program to inspect all properties in Libby. The emergency response work in Libby has focused on removing as many LA source areas as possible from all OUs. Contaminated soils are transported to the former Libby Mine site and contaminated construction debris is placed in a specially designed landfill cell. These disposal sites are secured and will remain off-limits to human contact. Recent response efforts have focused on residences and businesses. Currently, the EPA is transitioning from emergency removal activity to the Remedial Process (EPA, 2010a).

In an effort to determine the extent of LA occurrence at OU5, there have been multiple sampling investigations conducted since 2002. These investigations are discussed in detail in Sections 3 and 5 of this report. A number of response actions have been completed to date and are summarized in Table 1-1. Those buildings and land areas subjected to prior response actions that remain at OU5 are illustrated on Figure 1-4.

The only known source of residual indoor vermiculite is at the Central Maintenance Building, where remnants of vermiculite insulation remain in wall cavities (CDM, 2007a). However, the possibility exists for residual vermiculite to be present in other OU5 buildings.

Beginning in October 2006, EPA implemented the Environmental Resource Specialist (ERS) program for the entire Libby Superfund Site, including OU5. This program was set up to assist

1.5 REGULATORY HISTORY

The following is a brief chronological summary of major regulatory actions taken at the Site.

- 1999 – Local concern alerts EPA to investigate asbestos in and around Libby, Montana
- 2002 – Libby Asbestos Site proposed for the NPL
- 2002 – Libby Asbestos Site formally added to the NPL
- 1999 through 2013 – Response actions taken to remove asbestos and vermiculite containing material throughout OU5 (Table 1-1)

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Beginning in October 2006, EPA implemented the Environmental Resource Specialist (ERS) program for the entire Libby Superfund Site, including OU5. This program was set up to assist with unplanned and urgent exposures to vermiculite attic insulation due to its association with LA. The ERS program provides a full-time service where property owners, firemen, and other affected personnel or citizens can obtain access to LA expertise outside the normal course of scheduled clean-up actions. The ERS program currently responds to reports of residual vermiculite in OU5 buildings.

In addition to addressing vermiculite (and associated LA) in buildings, EPA performed other response actions involving OU5 soils (Figure 1-4):

- OU5 Redevelopment Area – Soil characterization and limited soil removal in an area west of the Pipe Shop. A summary of investigative and soil removal work is provided as Appendix A1.
- Central Maintenance Building – Multiple actions to remove vermiculite-containing building and other materials by vacuum methods, from the edge of the walls and outward approximately 45 ft. A summary of investigative and soil removal work as well as asbestos containing building materials mitigation is provided as Appendix A2.
- Libby Creek Remediation Area – Removal and replacement of rip-rap on the east bank of Libby Creek. Libby Creek is a part of OU4 as it traverses OU5. However, a portion of the response action may have encroached onto OU5 on the east bank of the creek. A summary of investigative and soil removal work is provided as Appendix A3.
- Former Plywood Plant – Soil removal north of the former veneer dryer and removal of vermiculite-containing bricks. A Completion Form is provided as Appendix A4.
- Valve House at Finger Joiner Building – Soil removal from the area surrounding the Valve House and from the floor of the Valve House. A Completion Form is provided as Appendix A5
- Former Popping Plant location – Soil removal as part of an OU4 action that extended onto OU5. A Completion Form is provided as Appendix A6.
- Port Authority Building (CDM Offices) – Soil removal as part of a re-vegetation pilot study. A Completion Form is provided as Appendix A7.
- Former Tree Nursery Area – Soil removal in preparation for construction of a proposed fishing pond in the area. Documentation is provided in Appendix A8.

In addition, EPA installed a chain-link fence to isolate the former Tree Nursery area (CDM, 2007a).

1.7 PREVIOUS INVESTIGATIONS & REPORTS

Numerous reports have been published dating back to 2007 that describe Site characteristics, as well as conditions on the entire NPL site. Many reports are considered relevant to the OU5 RI and are listed by primary subject as follows:

<u>Sampling and Analysis Plans</u>

- *Sampling and Analysis Plan, Building Data Gap Sample Collection, CDM, Final – 11/2/07*
- *Sampling and Analysis Plan, Initial Soils Data Gap Sample Collection, CDM, Final – 9/10/07*
- *Sampling and Analysis Plan Addendum - Initial Soils Data Gap Sample Collection, Visual Vermiculite Inspection, CDM, Final – 6/13/08*
- *Sampling and Analysis Plan for the MotoX, U.S. Department of Transportation, Final – 8/19/08*
- *Sampling and Analysis Plan for Outdoor Worker Exposures, Syracuse Research Corp., Final – 9/8/08*
- *Sampling and Analysis Plan for Recreational User Exposures, Syracuse Research Corp., Final – 9/8/08*
- *OU5 Activity Based Sampling, Soil Pilot Study (Modification to MotoX ABS SAP & Outdoor Worker ABS SAP), CDM, Rev 1 – 11/28/09*

<u>Reports on Investigation Results</u>

- *Data Summary Report, CDM, Final – 9/10/07*
- *Sampling Summary Report – 2007 Investigations, CDM, Final – 7/25/08*
- *OU5 Wood Chip ABS Sampling Summary Technical Memorandum, CDM Smith – 1/9/12*

1.8 LIBBY GROUNDWATER SITE

The LG Site lies within the OU5 boundary but is otherwise, unrelated to OU5 (Figure 1-2). A brief chronology and description of the LG Site history is provided below:

- In 1979, contamination was discovered in a nearby residential drinking water well. Contaminants include creosote, PCP (pentachlorophenol), and PAH's (polycyclic aromatic hydrocarbons).
- LG Site added to the NPL on September 8, 1983. It has two designated OUs:
  - LG-OU1 consists of the alternative drinking water supply initiative sponsored by Champion (a PRP) for the affected and potentially-affected residents of Libby.
  - LG-OU2 consists of affected environmental media including contaminated soils, and groundwater in the upper and lower aquifer.

- LG-OU1 Record of Decision (ROD) was finalized on September 26, 1986. The remedy included:
    - Champion's Buy Water Plan in which Libby residents were provided monetary compensation for using municipal water supply for irrigation and drinking water instead of contaminated private water wells.
    - An ordinance preventing installation of new water wells for human consumption or irrigation in the upper and lower aquifer within the "corporate limits" for the City of Libby.

- LG-OU2 ROD was finalized on December 30, 1988. The remedy included but is not limited to:
    - Excavation of contaminated soils from identified source areas and placement within a waste pit to undergo a two-step enhanced biodegradation process. The solids were transferred to a land treatment unit, which ultimately will be capped with low permeability materials.
    - Insertion of language into the current registered deed identifying locations of hazardous substances disposal and treatment areas, and land use restriction of these areas.
    - Oil recovery wells to collect highly-contaminated ground water, which is treated in a fixed film bioreactor prior to reinjection.
    - In-situ enhanced biorestoration of upper aquifer ground water.
    - Monitoring activities to assess performance of remedy components throughout the life of remedial activities.

Four 5-year reviews have been performed at the LG Site, with the most recent signed on March 5, 2010. The review found the current remedies for LG-OU1 and LG-OU2 to not be protective. The remedy for LG-OU2 does not include institutional controls on a portion of the contaminated groundwater plume. The remedy for LG-OU2 does not currently meet risk-based cleanup levels. Environmental clean-up activities at the LG Site will continue into the future.

2.0 SITE CHARACTERISTICS

2.1 CLIMATE

Annual average precipitation in Libby is 24.7 inches, with an annual average of 105 inches of snowfall (WRCC, 2010). Precipitation and humidity in Libby are greatest during the winter months due to the presence of temperature-regulating Pacific air masses. In December and January, average temperatures range between 25-30 °F. Occasionally, dry continental air masses occupy the Libby area for short periods of time during the winter, creating cold and less-humid conditions (CDM, 2009a).

Fog is common in Libby during winter months and in early morning throughout the year. Summer months are dryer and warm with occasional rainfall. The average July temperature ranges between 56-70 °F, with an average high of 80 °F (CDM, 2009a).

Prevailing winds are from the west north-west and average approximately 6-7 miles per hour. Wind direction and velocities fluctuate depending on temperature variances caused by vertical relief in the area. Inversions often trap stagnant air in the Libby valley (CDM, 2009a).

2.2 GEOLOGY

Regional geology in the Libby valley is comprised of lacustrine deposits underlain by Precambrian rocks. Surrounding mountains are formed by Precambrian rocks. Cliffs along the lower portion of the valley are formed by glacial lake bed deposits. The Kootenai River and Libby Creek cut through lacustrine and alluvial deposits and form a discontinuous sequence of gravel, sand, silt, and clay (EPA, 2010b).

Alluvial deposits extend from the surface to 190 ft bgs and are comprised of sand, gravel, silt, clay and cobbles. Glacial till, which consist primarily of silt and clay with varying amounts of sand and gravel underlies alluvial deposits. Deposits of glacial till are believed to be quite deep, occurring at depths exceeding 500 ft bgs (EPA, 2010b).

Soils in the Libby area typically are loamy soil composed of sand and silt with minor amounts of clay. Soil was formed by erosion of pre-Cambrian rocks, downstream transport of clays with rivers and creeks, and organic matter from historically forested areas (CDM, 2009a).

Site soils are a combination of historical soil modified in areas by human activities. These activities may include addition of vermiculite as a soil amendment, soil reworking for building construction, road and railroad operation, vermiculite processing and transport, and general site work.

2.3 HYDROLOGY AND HYDROGEOLOGY

Libby Creek (which is part of OU4) runs through the western portion of OU5 and terminates in the Kootenai River, which flows just outside the northern OU5 border. The Kootenai River originates in British Columbia, Canada, and flows through Montana and Idaho before returning to Canada and flowing into the Columbia River. Flows in the Kootenai River and Libby Creek are tied to runoff from the mountains surrounding Libby. Runoff peaks in spring when high-elevation snow begins to melt. Stream flow decreases in summer due to low precipitation and snowmelt flow moderation by high elevation lakes (CDM, 2009a).

Beneath OU5, saturated alluvial deposits extending from the surface to approximately 190 ft bgs have been sorted into three classifications: upper aquifer, intermediate zone, and lower aquifer. The upper aquifer contains high hydraulic conductivity material including silty gravel and sand with occasional interbedded clayey, silty deposits. It is unconfined and extends from the water table (5 to 30 ft bgs) to approximately 70 ft bgs. Hydraulic conductivity ranges from 100 to 1000 foot per day (ft/day). The inferred groundwater flow direction is north-northwest towards the Kooteni River (EPA, 2010b).

The intermediate zone is comprised of low permeability deposits similar to the upper aquifer, but with a higher percentage of fine-grained material. Acting as a confining layer, the intermediate zone is 40 to 60 ft thick, extending from approximately 60-70 ft bgs to 110 ft bgs. The hydraulic conductivity of this layer is much lower than the upper aquifer at approximately 1 ft/day.

The lower aquifer extends from approximately 100 ft bgs to 190 ft bgs, and contains more low-permeability silt and clay layers than the upper aquifer. It is confined and under pressure, so water in wells screened in this aquifer rise to 14-26 ft bgs. Hydraulic conductivity of the lower aquifer ranges from 50 to 200 ft/day. The inferred groundwater flow direction is north-northwest towards the Kooteni River (EPA, 2010b).

3.0 SAMPLING AND ANALYSIS

Investigations at OU5 began in May of 2002 and continued through 2012. Table 3-1 summarizes sampling events that occurred at OU5 over the ten-year sampling period.

The following sections describe sample types, sample collection and analytical methods. All sample media and associated analytical results are discussed in this Section. However, certain data are excluded from the discussion of nature and extent of LA occurrence (Section 4) including:

- Air, bulk material or other samples associated with a building/structure that has since been demolished or otherwise destroyed or has been cleaned under a removal action.

- Certain other data that was deemed irrelevant to the assessment of risk to human health. These include certain indoor dust and outdoor ambient air samples.

This was done to simplify and focus the description of nature and extent of LA occurrence to those measurements most relevant to the estimation of human health risks.

In addition, investigations performed after 2009 were in support of lumber product safety assessment or pre-design investigations related to site development. Data from these studies were also excluded from the body of the report. However, a summary of each investigation is provided in Section 5.

3.1 SAMPLE TYPES AND COLLECTION PROCEDURES

As shown in Table 3-1, the following media-specific sampling was conducted:

- Air
  - ➢ Personal air samples – collected using a sampling pump and filter located in the breathing zone of an individual while performing various activities indoors or outdoors.
  - ➢ Stationary air samples – collected using a stationary sampling pump and filter placed either indoors or outdoors.
- Dust - standing dust samples collected from horizontal surfaces inside buildings.
- Soils
  - ➢ Surface – composite and grab samples collected from 0 to 6 inches bgs.
  - ➢ Sub-surface – composite and grab samples collected 6 or more inches bgs.
- Waste Bark - material samples from existing waste pile shown on Figure 1-3.

Samples were collected, documented, and handled in accord with standard operating procedures (SOPs) as specified in the respective Sampling and Analysis Plans (SAPs). The Data Summary Report and Sampling Summary Report (CDM, 2007a and CDM, 2008) provide additional details on sampling events as well as deviations from the SAPs.

Data documenting sample type, location, collection method, and collection date were recorded both in a field log book maintained by the field sampling team and on a field sample data sheet (FSDS) designed to facilitate data entry into the Libby site database, as described in Section 4.1. All samples collected in the field were maintained under chain of custody during sample handling, preparation, shipment, and analysis.

3.1.1 Air Samples

All air samples were collected by drawing a sample through a filter that traps asbestos and other particulate material on the face of the filter. Two main categories of air samples were collected:

1. Personal Air Samples - Sampling equipment worn by a person or affixed to a piece of operating equipment/vehicle. Samples collected both indoors and outdoors.

2. Stationary Air Samples - Sampling equipment placed on motionless surface. Samples collected both indoors and outdoors.

Personal air sampling involved a variety of activities performed by the sampler with and without operating equipment/vehicle. These activities may have been scripted or unscripted. Scripted activities required the sampler and/or equipment to perform a written script. Unscripted activities are those for which a formal written script was not used. For example; a scripted activity might involve a sampler performing specific office work routine while wearing a sampling pump and filter cassette in a building with current use as an office. An unscripted activity might involve the sample equipment worn by a site worker going about his/her self-determined routine.

Unscripted personal air data was most frequently collected in association with Occupational Safety and Health Administration (OSHA) exposure monitoring for workers on OU5. These data were not intended for use in site characterization or for estimation of residual risks to current or future populations at OU5.

Stationary sampling included sampling of ambient air at OU5 but also included sampling proximal to a person or piece of equipment conducting scripted activities. Scripted stationary air samples were collected to represent conditions in the breathing zone as a surrogate for a personal air sample.

Such sampling was conducted at a variety of locations including but not limited to:

- Unoccupied buildings while disturbing the dust with a leaf-blower or equivalent.
- Proximal to stadium seating at the MotoX Park during a race.

Inhalation of air is considered to be the most direct route of exposure to LA and is therefore the primary medium of concern. Scripted air sampling activities were determined to provide the most meaningful measure of human exposure to LA at OU5 (EPA, 2008a). Such scripted sampling is referred to in the remainder of this report as Activity-Based Sampling (ABS).

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All ABS events were conducted in accord with EPA's Emergency Response Team (ERT) SOP #2084 (Activity-Based Air Sampling for Asbestos), with project-specific modifications. Activity-Based Sampling was conducted to evaluate possible exposure of a variety of populations at OU5 including commercial/industrial workers, maintenance workers and recreational visitors. Activity-Based Sampling was conducted at locations shown on Figure 3-1 to target the following populations at OU5:

- Visitors participating in and viewing MotoX activities at the MotoX Park (EPA, 2008b)
- Visitors riding a bicycle on the bike path along Libby Creek (EPA, 2008c)
- Workers engaging in outdoor activities at various locations on OU5 (EPA, 2008d; CDM, 2007)
- Workers engaging in indoor activities in various buildings on OU5 (EPA, 2007a)

Activities include raking, operating machinery, riding a bike or motorcycle, moving waste bark and active and passive indoor worker activities. The intent was to disturb LA containing materials (ie. soil or dust) by performing an activity typical for a given building or outdoor location allowing measurement of actual LA exposure for that activity.

A detailed description of the study design and data quality objectives (DQOs) for each ABS study is provided in the respective SAPs, cited above.

As part of the OU5 outdoor worker ABS investigation, sampling was conducted at eight ABS areas (Figure 3-1) (EPA 2008d). Each ABS area was approximately 1-1.5 acres in size. These eight ABS areas were selected based on previous visible vermiculite sampling results to represent the range of expected soil contamination conditions at the OU5 site.

All outdoor ABS air sampling was performed in September or October in order to make measurements during the time of year where conditions are drier than most other months.

3.1.2 Dust Samples

Indoor dust samples were collected as part of four different sampling programs; Phase 1 investigation in May 2002, Contaminant Screening Study in September 2002, Pre-Design Inspection for the Central Maintenance Building in April 2004 (CDM, 2007a), and Building Data Gap Sample Collection (EPA, 2007a).

Dust samples were collected from horizontal surfaces such as a shelf or floor inside buildings. Samples were collected using a microvacuum dust filter that was operated for between two and five minutes. Each sample was a composite consisting of up to ten, 100-square centimeter (cm^2) areas.

These data were primarily used to assess whether an occupied building should be considered for emergency cleanup. As discussed in Section 5.3, several buildings contained dust above the action threshold of 5,000 LA structures per cm^2 (s/cm^2).

As discussed in Section 3.1.1 and 5.2, ABS was conducted in occupied and vacant buildings, including buildings previously subjected to cleaning of interior surfaces and/or removal of LA-containing building materials (e.g. vermiculite insulation). Results of indoor ABS are discussed in Sections 5.2 and 5.3.

3.1.3 Soil Samples

Surface Soil

Most soil sampling at OU5 involved surface soils. Soil sampling at OU5 began in 2002 with an initial phase that included systematic sampling across most of OU5 as well as a focused investigation of four specific areas of interest including:

- Soils near the Central Maintenance Building
- MotoX Park
- A proposed demolition derby track
- Former Tree Nursery area.

At least multiple additional sampling events occurred after the initial 2002 event in order to gain a more complete understanding of the occurrence of LA and/or vermiculite in soil (Table 3-1). Reasons for additional sampling included areas not originally sampled, areas known to have vermiculite containing materials and areas of high use. A discussion of soil sample strategies is provided in:

- Data Summary Report, Operable Unit 5 – Former Stimson Lumber Company, Libby Asbestos Site, Libby, MT (CDM. 2007a).

- Sampling Summary Report, 2007 Investigations, Operable Unit 5 – Former Stimson Lumber Company, Libby Asbestos Site, Libby, MT (CDM. 2008).

Soil samples included grab and composite samples. Grab samples were collected as a shallow core approximately 2 inches in diameter and no more than 6 inches bgs. Composites were comprised of between two and thirty grab samples. In some cases, the individual grab samples were analyzed along with the composite.

Figure 3-1 shows locations of all surface soil samples (grab or composite) that were collected and analyzed (or otherwise examined). The variability in sample density apparent on this figure relates to the various strategies employed to characterize surface soils at OU5 during period of field investigations (2002-2009).

An initial, roughly systematic sampling event was intended to provide general coverage of OU5. Sample spacing of this initial event is apparent in the west-central portion of OU5 (Figure 3-1). This initial investigation omitted the LG Site, which was later subject to additional, relatively dense systematic sampling as shown on the figure.

Subsequent localized investigations of surface soil focused on specific areas where vermiculite (and therefore, associated LA) was either observed or otherwise suspected to be present based on historical land use (e.g., former vermiculite popping plant).

In addition, locations with current or proposed high-use recreational lands were also the target of stand-alone investigations. These included the MotoX Park (Figure 3-1) and a proposed demolition derby (proximal to the MotoX Park).

Prior to selecting the locations for Outdoor Worker ABS events, all existing OU5 surface soil data were examined to discern trends in spatial variability of LA or vermiculite occurrence. The purpose of this exercise was to allow selection of Outdoor Worker ABS locations that represented a range of surface soil contamination.

Ultimately, outdoor worker ABS areas were selected based on visual vermiculite inspection results. Previous sampling activities characterized vermiculite levels throughout most of OU5 based on visual inspection, and this information was used to categorize the level of vermiculite in the soil as None, Low, Moderate or High based on relative scoring (See Section 3.2.2). Outdoor Worker ABS areas were selected to include two areas from each category. Table 3-2 shows the visible inspection scores at the selected locations for the Outdoor Worker Exposure ABS. Outdoor Worker ABS locations are shown on Figure 3-1.

Once outdoor ABS locations were selected (for worker and recreational land uses), those areas were subject to additional surface soil sampling (as shown on Figure 3-1). All ABS areas were characterized by collecting and analyzing at least 30 individual grab samples and then also analyzing a 30-point composite sample comprised of the grabs. Most samples were analyzed to determine presence of LA. Analytical methods are discussed in Section 3.2.2.

The purpose of this additional sampling was three-fold:

- Verify that outdoor worker ABS areas did represent a range of LA levels and visible vermiculite conditions.
- Produce data that could be used to develop a mathematical relationship between LA occurrence in soil and in air.
- Evaluate whether composite sampling of OU5 soils is masking variability of LA occurrence in grab samples.

Subsurface Soil

Subsurface samples were collected in limited areas. Generally, these areas were selected based on the location of suspected buried LA containing materials including the former Popping Plant and a buried railroad spur (Figure 1-3). Sampling at these locations as well as a few scattered locations across OU5 included composites consisting of five grab samples collected from depths of 40 to 60 inches bgs. Additional subsurface grab samples were collected as part of the LG Site investigation in 2007. These samples were collected from depths of 12-15 inches bgs.

3.1.4 Waste Bark

Waste bark is stored on OU5 in stockpiles (see Figure 1-3). On October 15, 2007, bulk waste bark debris samples were collected to test for a presence of LA and to evaluate removal options and potential future uses.

Waste bark piles were split into 100 ft by 100 ft grids. Sampling was conducted using a test pit method in each grid. A total of 27 bulk material samples and one field duplicate were collected from the top, middle and bottom section of each waste bark test pit. Of these 27 samples, 19 field samples and one field duplicate were analyzed. The remaining samples may be analyzed at a later date, as directed by the EPA (CDM, 2008).

3.2 SAMPLE PREPARATION AND ANALYSIS

A detailed description of the number of samples analyzed from each sampling event, sampling and analytical methods used and detection results is provided in Appendix B. A thorough description of sample preparation and analytical methodology is also provided in Appendix C and summarized below.

3.2.1 Air and Dust

In the past, the most common technique for measuring asbestos in air was phase contrast microscopy (PCM). In this technique, air is drawn through a filter and airborne particles become deposited on the face of the filter. All structures that have a length greater than 5 micrometers (um) and have an aspect ratio (the ratio of length to width) of 3:1 or more are counted as PCM fibers. The limit of resolution of PCM is about 0.25 um, so particles thinner than this are generally not observable.

A key limitation of PCM is that particle discrimination is based only on size and shape. Because of this, it is not possible to classify asbestos particles by mineral type, or even to distinguish between asbestos and non-asbestos particles. For this reason, nearly all samples of air collected in Libby are analyzed by transmission electron microscopy (TEM).

This method operates at higher magnification (typically about 20,000x) and hence is able to detect structures much smaller than can been seen by PCM. In addition, TEM instruments are fitted with accessories that allow each particle to be classified according to mineral type.

If air samples were not deemed to be overloaded by particulates[1], filters are directly prepared for analysis by TEM in accord with preparation methods provided in International Organization for Standardization (ISO) 10312 (ISO, 1995).

[1] Overloaded is defined as >25% obscuration on the majority of the grid openings (see Libby Laboratory Modification #LB-000016 and SOP EPA-LIBBY-08).

If air samples are deemed to be overloaded, samples are prepared indirectly in accord with procedures in SOP EPA-LIBBY-08. In brief, rinsate or ashed residue from the original filter is suspended in water and sonicated. An aliquot of this water is applied to a second filter which is then used to prepare a set of TEM grids. Reported air concentrations for indirectly prepared samples incorporate a dilution factor.

Air and dust samples collected as part of the OU5 sampling programs were analyzed by TEM in basic accord with counting and recording rules specified in ISO 10312, and project-specific counting rule modifications specified in the respective SAPs. These modifications included changing the recording rule to include structures with an aspect ratio ≥ 3:1.

For each countable structure particle identified, the analyst records structure-specific information (e.g., length, width, asbestos mineral type) which is then used to calculate air concentration in LA structures per cubic centimeter (s/cc) or dust loading in s/cm^2.

3.2.2 Soil and Bulk Material

Polarized Light Microscopy (PLM)

Soil samples collected as part of the OU5 sampling programs were prepared for analysis in accord with SOP ISSI-LIBBY-01 as specified in the CDM Close Support Facility (CSF) Soil Preparation Plan (CDM, 2004). In brief, each soil sample is dried and sieved through a ¼ inch screen. Particles retained on the screen (if any) are referred to as "coarse" fraction. Particles passing through the screen are referred to as fine fraction, and this fraction is ground by passing it through a plate grinder. Resulting material is referred to as "fine ground" fraction. The fine ground fraction is split into four equal aliquots; one aliquot is submitted for analysis and the remaining aliquots are archived at the CSF.

Soil samples are analyzed using PLM whereby the analyst estimates the amount of asbestos in the sample (expressed as percent by weight) based on visual estimation techniques and by comparison to reference materials.

The coarse fractions were examined using stereomicroscopy, and any particles of asbestos (confirmed by PLM) were removed and weighed in accord with SRC-LIBBY-01 (referred to as "PLM-Grav"). Fine ground aliquots were analyzed using a Libby-specific PLM method using visual area estimation, as detailed in SOP SRC-LIBBY-03. For convenience, this method is referred to as "PLM-VE."

PLM-VE is a semi-quantitative method that utilizes site-specific LA reference materials to allow assignment of fine ground samples into one of four "bins," as follows:

- *Bin A (ND):* non-detect
- *Bin B1 (Trace):* detected at levels lower than the 0.2% LA reference material

- *Bin B2 (<1%):* detected at levels lower than the 1% LA reference material but higher than the 0.2% LA reference material
- *Bin C:* LA detected at levels greater than or equal to the 1% LA reference material

Visual Inspection

For soil samples, field teams also provide a semi-quantitative estimate of visible vermiculite present at soil sampling point(s). Visual inspection data can be used to characterize the level of vermiculite (and presumptive LA contamination) in an area and considers both frequency and level of vermiculite. This is achieved by assigning a weighting factor to each level, where weighting factors are intended to represent relative levels of vermiculite in each category. As presented in SOP CDM-LIBBY-06, guidelines for assigning levels are as follows:

- None – No flakes of vermiculite observed within the soil sample.
- Low – A maximum of a few flakes of vermiculite observed within the soil sample.
- Moderate – Vermiculite easily observed throughout the soil sample, including the surface and contains <50% vermiculite.
- High – Vermiculite easily observed throughout the soil sample, including the surface and contains 50% or more vermiculite.

Based on these descriptions, weighting factors used to characterize magnitude of LA occurrence in soil are as follows:

Visible Vermiculite Level (L_i)	Weighting factor (W_i)
None	0
Low	1
Moderate	3
High	10

The composite score is then the weighted sum of the observations for the area:

$$Score = \frac{\sum_{i=1}^{30} L_i * W_i}{30}$$

This value can range from zero (all 30 points are "none") to a maximum of 10 (all 30 points are "high"). For example, an ABS area with 1 "low" point and 29 "none" points would receive a value of 1/30 = 0.033, while an ABS area with 24 "intermediate" points and 5 "high" would receive a score of (24·3 + 5·10) / 30 = 4.13.

In addition to the visual estimation method described above, field crews used a less sophisticated technique prior to implementation of SOP CDM-LIBBY-06 in 2006. This involved noting in the field the simple presence or absence of visible vermiculite in soil samples.

3.2.3 Waste Bark

Waste bark samples were analyzed by adding a sample of test material to water, shaking, and allowing the sample to separate into "sinks" (mineral particles that settle to the bottom), "floats" (particles of wood that rise to the top), or "suspended" (particles that remain in the water). The "sinks" are collected, dried, and analyzed using EPA-Libby-10, Analysis of Waste Bark and Wood Chip Samples for Fibrous Amphibole, a qualitative analysis method utilizing PLM and TEM. If no fibrous amphibole is detected in the "sinks", then a sample of the water is analyzed by TEM for suspended amphibole. If fibrous amphibole is detected in either fraction, the sample is reported as "detect". If fibrous amphibole is detected in neither fraction, the sample is reported as "non-detect".

4.0 DATA RECORDING, DATA QUALITY ASSESSMENT, AND DATA SELECTION

4.1 DATA RECORDING

All analytical results are stored and maintained in the Libby 2 Database (Libby2DB) and more recently the Libby Data Warehouse. Appendix D1 provides an electronic copy of the database.

Detailed summaries of sample results for environmental media collected in OU5 through 2007 are provided in CDM (2007a) and CDM (2008). Standardized data entry spreadsheets (electronic data deliverables or EDDs) have been developed specifically for the Libby project to ensure consistency between laboratories in the presentation and submittal of analytical data. In general, a unique EDD has been developed for each type of analytical method. Each EDD provides the analyst with a standardized laboratory bench sheet and accompanying data entry form for recording analytical data. Data entry forms contain a variety of built-in quality control functions that improve accuracy of data entry and help maintain data integrity. These spreadsheets also perform automatic computations of analytical input parameters (e.g., sensitivity, dilution factors, and concentration), thus reducing the likelihood of analyst calculation errors. The EDDs generated by the laboratories are uploaded directly into the Libby site database.

Hard copies of all FSDSs, field log books, and chain of custody forms generated during the various OU5 sampling program are stored in the CDM field office in Libby, Montana.

Hard copies of all analytical bench sheets are included in analytical laboratory reports. These analytical reports are submitted to the Libby Laboratory Coordinator and stored at CDM offices in Denver, CO.

Historically, sample and analytical electronic data were stored and maintained in the Libby2DB which was housed on a structured query language (SQL) server at EPA Region 8 in Denver, Colorado. At the time of this report, EPA was in the process of transitioning to a new data management system, referred to as Scribe.net. In the future, sample and analytical electronic data will be stored and maintained in the Libby Data Warehouse which is populated by Scribe.net and housed on the EPA network.

4.2 DATA QUALITY ASSESSMENT

Data quality assessment (DQA) is the process of reviewing existing data to establish the quality of the data and to determine how any data quality limitations may influence data interpretation (EPA, 2006). The full DQA is provided as Appendix E.

For the purposes of the risk assessment (Section 7), the principle datasets utilized to quantify potential exposures are the air samples collected during the various ABS programs at OU5.

In addition, soil data (both visible vermiculite inspection results and PLM-VE results) are utilized in the interpretation of Outdoor Worker ABS results. Therefore, the DQA focuses on ABS air samples and Site-wide soil samples used to support the risk assessment.

The DQA process considered the following:

- Field and laboratory audit results.
- Field and laboratory quality control sample results.
- Data entry verification.
- Comparison of data collected with specified DQOs stated in the respective ABS SAPs.

Results of the DQA indicate that air and soil data collected at OU5 and utilized in the risk assessment generally are of acceptable quality, adequate and representative, and considered to be reliable and appropriate for use in the RI including the risk assessment.

4.3 DATA SELECTION

Raw data for samples utilized in describing the occurrence of LA in OU5 soils and air (Section 5) were obtained via a subscription to the Libby OU5 project database through Scribe.net. A copy of this database was obtained by SRC, Inc. on March 12, 2010, and is provided electronically in Appendix D1 of this report.

Because all data had not yet been migrated from Libby2DB to Scribe.net at the time of this report (e.g., quality control samples and analyses, air pump information, etc.), data were supplemented by results from the Libby2DB. The Libby2DB was downloaded into a Microsoft Access® database by SRC, Inc. on December 8, 2009. Note that any changes made to these databases since they were obtained/download will not be reflected in Appendix D1.

In addition, supplemental GPS coordinate data for historical soil samples were provided by CDM on March 25, 2010. An Microsoft Excel® spreadsheet summarizing these coordinate data is provided in Appendix D1.

Scribe queries were written to sort data by media, analytical method and to exclude quality control samples. The Scribe queries for soil and air samples are provided in Appendix D2. The data set resulting from execution of the queries was used to describe the nature and extent of LA occurrence.

5.0 NATURE AND EXTENT OF LA

5.1 CONTAMINANTS OF CONCERN

The contaminant of concern at the Libby Site is asbestos. Asbestos is the generic name for the fibrous form of a broad family of naturally occurring poly-silicate minerals. Based on crystal structure, asbestos minerals are usually divided into two groups - serpentine and amphibole.

- Serpentine - The only asbestos mineral in the serpentine group is chrysotile. Chrysotile is the most widely used form of asbestos, accounting for about 90% of the asbestos used in commercial products (IARC, 1977). There is no evidence that chrysotile occurs in the Libby vermiculite deposit, although it may be present in some types of building materials in Libby.

- Amphibole – Five minerals in the amphibole group that occur in the asbestiform habit have found limited use in commercial products (IARC, 1977), including actinolite, amosite, anthophyllite, crocidolite, and tremolite.

At the Libby Site, the form of asbestos that is present in the vermiculite deposit is amphibole asbestos that for many years was classified as tremolite/actinolite (e.g., McDonald et al., 1986a, Amandus and Wheeler, 1987). More recently, the U.S. Geological Service (USGS) performed electron probe micro-analysis and X-ray diffraction analysis of 30 samples obtained from asbestos veins at the mine (Meeker et al., 2003). Using mineralogical naming rules recommended by Leake et al. (1997), the results indicate that asbestos at Libby includes a number of related amphibole types. The most common forms are winchite and richterite, with lower levels of tremolite, magnesioriebeckite and possibly actinolite.

Because mineralogical name changes that have occurred over the years do not alter the asbestos material that is present in Libby, and because EPA does not find that there are toxicological data to distinguish differences in toxicity among these different forms, the EPA does not believe that it is important to attempt to distinguish among these various amphibole types. Therefore, EPA simply refers to the mixture as (LA).

5.2 LA IN AIR

The amount of LA fibers released to air will vary depending upon the level of LA in the source material (e.g., outdoor soil, indoor dust) and the intensity and duration of the disturbance activity. Because of this, predicting the LA levels in air associated with disturbance activities based only on measured LA levels in the source material is extremely difficult. Therefore, ABS is considered to be the most direct way to estimate potential exposures from inhalation of asbestos. ABS results for indoor and outdoor air are summarized on Figures 5-1 and 5-2, respectively.

Indoor Air

Figure 5-1 summarizes ABS results for existing buildings except those that have fewer than four walls or have a dirt floor. In addition, no ABS air data is available for the Finger Jointer Process Plant.

Samples from most vacant buildings contained no detectable LA. Samples from most occupied buildings contained detectable LA. For buildings where LA was detected, the mean concentration varied by a factor of 1,000.

Outdoor Air

Figure 5-2 summarizes results for the eight Outdoor Worker ABS locations and ABS conducted along the bicycle path and at the MotoX Park. LA was detected in seven of the eight Outdoor Worker ABS areas. The mean LA concentration varied by a factor of 10 across the seven areas where LA was detected.

Sampling at the MotoX Park included stationary samplers proximal to the location of spectators as well as samplers fixed to handlebars of dirtbikes. No LA fibers were detected in any sample.

Sampling was conducted separately for paved and unpaved portions of the bike path. On the paved path, a stationary air monitor was also mounted in a trailer attachment to one of the bicycles to characterize potential exposures to a young child being pulled by a parent. Samples from the trailer were not collected from the unpaved portion of the path because the unpaved portion of the path is steep and narrow in sections, and is not safe for pulling a trailer. The mean LA concentrations for the adult and child were similar.

5.3 LA IN DUST

Figure 5-3 illustrates buildings that have been sampled for indoor dust and presents the total LA dust loading results relative to the current EPA removal action level for indoor dust (> 5,000 total LA s/cm^2; EPA, 2003).

Of the 87 indoor dust field samples collected, 28 samples had detectable levels of LA, with detectable levels ranging from 35 to 44,116 total LA s/cm^2. Only four samples had detectable levels of LA above the current EPA removal action level:

- Former Tree Nursery area shed – Total LA dust loading was 7,026 s/cm^2 for one composite sample collected in May 2002 from sampling locations atop wood piles and from a ground level beam in this shed. This building was no longer present during the 2007 site visit (CDM, 2007a).
- Central Maintenance Building – Total LA dust loading was 8,823 s/cm^2 for one of 29 composite samples collected from this building in September 2002. This sample was

collected from two engine rooms and the main work area. The source of dust contamination in this building was likely vermiculite insulation and vermiculite-containing building materials which were subsequently removed in 2005 (CDM, 2007a).

- Diesel Fire Pump House – Total LA dust loading was 8,823 s/cm^2 for one composite sample collected from three areas within this building in September 2002.

- Guard Station at Libby Creek Bridge – Total LA dust loading was 44,116 s/cm^2 for one composite sample collected from this building in September 2002. The guard station did not contain vermiculite insulation at the time of sampling (CDM, 2007a). This building was no longer present during the 2007 site visit (CDM, 2007a).

5.4 LA IN SOIL

Surface Soil

Figure 5-4 illustrates LA occurrence in OU5 surface soils based on PLM results. A 4-color scheme is used to indicate the amount of LA present in a sample (additional detail on analytical reporting is provided in Appendix C):

- green = Bin A (non-detect)

- yellow = Bin B1 (trace)

- orange = Bin B2 (< 1%)

- red = Bin C (≥ 1%)

In this figure, individual grab samples (primarily collected within the Outdoor Worker ABS areas) are shown as triangles, and composite samples are shown as circles plotted at the mid-point of the area. Composite samples are representative of a larger area than the plotting point presented in this figure.

Figure 5-5 illustrates vermiculite occurrence in OU5 soils based on visual vermiculite inspection results. In this figure, historical observations of visible vermiculite which utilized a qualitative present/absent approach are shown as triangles.

More recent visible vermiculite observations which utilized a semi-quantitative approach are shown as squares and are color-coded based on the visible score (see Section 3.2.2). A 4-color scheme is used to indicate visible score data:

- green = score of 0 (no visible detected)

- yellow = score < 0.1

- orange = score 0.1 to < 0.3

- red = score > 0.3

One potential limitation to the approach for presenting visible score data is that the choice of cut-offs for use in color-coding is arbitrary. If other cut-offs were chosen, the appearance of the figures would be different. For example, the cutoff for red is 0.3 out of a possible score of 10. Nevertheless, the figures do provide a useful indication of the degree to which there is variation across OU5 and locations where higher than average levels have been observed.

As shown in Figure 5-4, PLM results are generally non-detect or trace across OU5. The one location where PLM results have consistently been higher (with observed LA levels up to 1%) is the north-central portion of the former Tree Nursery area. This location also has elevated visible scores (see Figure 5-5).

Differences in the more recent visual vermiculite results compared to the original results likely arises from the inherently subjective nature of the category assignments, as well as variations in site conditions between rounds (e.g., cloud cover vs. sunshine, amount of ground cover, soil moisture, etc.).

Subsurface Soil

PLM and visual inspection results for subsurface soils are presented on Figure 5-6. LA was not detected in any composite sample collected near the former Popping Plant or in other samples scattered across the remainder of OU5. LA was reported as <1% in a single composite sample collected along the railroad spur.

LA was not detected in any of the grab samples collected in the LG Site. Visible vermiculite was noted as "moderate" in a single sample. Unlike the visible vermiculite score used to describe the relative level of vermiculite in composite samples, the result for individual grab samples is expressed as none, low, moderate or high, as discussed Section 3.2.2.

These results suggest that, in the areas examined, the occurrence of LA or vermiculite does not increase with depth.

5.5 LA IN WASTE BARK

Of the 19 waste bark samples analyzed, LA was detected in 1 sample analyzed by PLM, and LA was detected in 13 samples by TEM. These results show that LA is present in these piles, but it is not possible to quantify how much LA may be present based on the qualitative method used for waste bark (See Section 3.2.3).

5.6 Supplemental Studies

As discussed in Section 3.0, several targeted investigations were performed after 2009. These included:

1. ABS air sampling during the handling of wood chips produced during historical lumber processing operations. The purpose of the investigation was to evaluate whether disturbance of the wood chips (by workers or residents) resulted in health risks above a level of concern. All of the ABS air sample results were non-detect for LA. Without fibers being detected, risks were not estimated as there was no exposure. A Memorandum summarizing the investigation and findings was prepared by CDM Smith is provided as Appendix F1.

2. Soil sampling to assess LA occurrence at the Former Tree Nursery to identify areas requiring excavation prior to design/construction of a proposed recreational fishing pond. Unpublished results indicated the presence of trace levels of LA in some of the areas sampled. Portions of the sampled areas were subsequently excavated (See Table 1-1 and Figure 1-4). A map illustrating the extent of LA in sampled areas is provided as Appendix F2.

6.0 CONTAMINANT FATE AND TRANSPORT

As discussed in Section 1.4, asbestos containing material was potentially transported to OU5 via the following activities:

- The former Popping Plant was once used as an aboveground storage area for uncontained vermiculite ore. Ore was stockpiled directly on the native soil surface in this area.
- The Railroad Spur was used for shipping raw and unprocessed vermiculite material to and from the site.
- The former Tree Nursery may have introduced raw vermiculite product into this area as a growth medium and fill material.

The fate and transport of asbestos containing fibers is dependent on the type of host media (soil, water, air, etc.), land use, and site characteristics. Asbestos fibers (both serpentine and amphibole) are indefinitely persistent in the environment. According to the Agency for Toxic Substances and Disease Registry (ATSDR):

> *"Asbestos fibers are nonvolatile and insoluble, so their natural tendency is to settle out of air and water, and deposit in soil or sediment (EPA 1977, 1979c). However, some fibers are sufficiently small that they can remain in suspension in both air and water and be transported long distances. For example, fibers with aerodynamic diameters of 0.1–1 μm can be carried thousands of kilometers in air (Jaenicke 1980), and transport of fibers over 75 miles has been reported in the water of Lake Superior (EPA 1979c)."* In addition, *"they are resistant to heat, fire, and chemical and biological degradation"* (ATSDR, 2001).

The primary transport mechanisms for asbestos and asbestos containing material include:

- Suspension in air and transport via dispersion
- Suspension in water and transport downstream

Asbestos can become suspended in air when asbestos or asbestos containing material is disturbed. Wind, recreational activities, construction, and site work can disturb material outdoors. Indoors, asbestos can be suspended when contaminated material (usually insulation) is disturbed by cleaning, renovation or other general disruption.

Asbestos residence time in the air is determined primarily by particulate thickness; however it is influenced by other factors such as length and static charge. The average thickness of LA particles is 0.4 μm and ranges from approximately 0.1 to 1.0 μm. The suspension of LA in air is measured in "half times" which is the amount of time it will take 50% of LA particles to settle out of the air column. A particle with a thickness of 0.5 μm has a half time of approximately two hours, assuming the source of disturbance has been removed.

Larger particles will settle faster; a particle of 1 μm has a half time of about 30 minutes. Smaller LA particles may stay suspended for significantly longer. The typical half time for a 0.15 particle is close to 40 hours (CDM, 2007a)

Activity-specific testing found that the half-time of LA suspended by dropping vermiculite on the ground was about 30 minutes. LA suspended from disturbing vermiculite.insulation settled within approximately 24 hours.

Once suspended, LA moves by dispersion through air. LA concentration will be highest near the source and will decrease with increasing distance. In outdoor air, wind speed will determine direction and velocity of LA particle transport. Wind can cause the rapid dispersal of LA from the source of release. In indoor air, mixing usually takes from 5 to 30 minutes, but is dependent on airflow within the building.

In water, LA particles can be transported downstream with the current. As in air, larger particles tend to settle to the bottom more rapidly than smaller particles. Settled particles may be transported downstream with sediment (CDM, 2009).

LA is insoluble and therefore transport in solution will not occur in surface water, groundwater or from soils to water. Further, as a particle, LA is not expected to be mobilized from surface or near surface soils vertically through the soil column to the water table.

7.0 HUMAN HEALTH RISK ASSESSMENT

An evaluation of potential exposures to and risks from LA will be included in the site-wide risk assessments for the Libby Asbestos Superfund Site. Site-wide risk assessments are stand-alone documents which support the feasibility study and ROD. As such, OU-specific risk assessment reports have not been developed.

The *Site-Wide Human Health Risk Assessment* will evaluate potential risks to humans from exposures to LA under a variety of different exposure scenarios, including both indoor and outdoor exposure scenarios that may occur at the Site. Potential risks will be evaluated both alone and across multiple exposure scenarios as part of a cumulative exposure assessment.

The *Site-Wide Ecological Risk Assessment* will evaluate potential risks to aquatic and terrestrial ecological receptors from exposures to LA that may be present in the environment at the Site.

Refer to the respective site-wide risk assessment reports to provide information on potential exposures and risks from LA to human and ecological receptors.

8.0 CONCLUSIONS

The RI reached the following general conclusions:

1. PLM results for surface soil samples are generally non-detect or trace across OU5. The one location where PLM results have consistently been higher (with observed LA levels up to 1%) is the former Tree Nursery area. This location also has elevated visible vermiculite scores.

2. PLM and visible vermiculite results for subsurface soil samples are generally non-detect. These results suggest that no increasing vertical gradient in LA or vermiculite occurrence exists in the areas examined. However, subsurface soil sampling across OU5 is limited.

3. Predicting the LA levels in air associated with disturbance activities based only on measured LA levels in the source material is extremely difficult. Therefore, ABS is considered to be the most direct way to estimate potential exposures from inhalation of asbestos.

4. An evaluation of potential exposures to and risks from LA will be included in the site-wide risk assessments for the Libby Asbestos Superfund Site. Site-wide risk assessments are stand-alone documents which support the field study (FS) and ROD.

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Tables

TABLE 1-1
Response Actions Taken at OU5

Location (reference)	Date	Lead Agency/Company	Description
Plywood Plant and Truck Shop (CDM 2007)	November 1999	MCS Environmental through Stimson Lumber Company	Asbestos abatement
Finger Jointer (CDM 2007)	May 2000	MCS Environmental through Stimson Lumber Company	Removal of vermiculite insulation from lunch room and bathroom
Dry Kiln Tunnel (CDM 2007)	December 2002	IRS Environmental through Stimson Lumber Company	Removal of pipe insulation and asbestos containing debris
Central Maintenance Building (CDM 2007)	May/June 2003	IRS Environmental through Stimson Lumber Company	Removal of vermiculite insulation and asbestos containing materials on ground surface
Plywood Dryers (CDM 2007)	August 2003	IRS Environmental through Stimson Lumber Company	Removal of vermiculite insulation from walls, floors, and ceilings
Plywood Plant (CDM 2007)	August 2003	IRS Environmental through Stimson Lumber Company	Removal of pipe insulation of northwest corner
Screening Building (CDM 2007)	August 2003	IRS Environmental through Stimson Lumber Company	Removal of cement asbestos siding and roofing
Central Maintenance Building (CDM 2007)	December 2003	IRS Environmental through Stimson Lumber Company	Removal and repair of asbestos containing roofing material and asbestos containing materials on ground surface
Former Nursery (CDM 2007)	Fall 2004	EPA	Installation of fence to isolate area
Finger Jointer Lunch Room (CDM 2007)	February 2005	IRS Environmental through Stimson Lumber Company	Removal of vermiculite insulation
Central Maintenance Building (CDM 2007)	Summer 2005	EPA	Removal of vermiculite insulation
Soils northwest of Pipe Shop to support redevelopment (CDM 2007)	Spring and Summer 2009	EPA	Removal of LA-impacted soils to depths of 6"-18" to support Site redevelopment.
Libby Creek (OU4 action w/possible encroachment on OU5) (CDM 2007)	August 2009	EPA	Removal and replacement of rip-rap on east bank of Libby Creek
Former Plywood Plant (EPA, 2010c)	Summer 2010	EPA	Soil removal north of former veneer dryer and removal of vermiculite-containing bricks.
Valve House at Finger Joiner Building (EPA, 2010d)	Summer 2010	EPA	Removal of soil and vermiculite-containing building materials.
Central Maintenance Building (EPA, 2010e)	January 2010	EPA	Removal of vermiculite-containing insulation and interior cleaning.

TABLE 1-1 (Continued)
Response Actions Taken at OU5

Location (reference)	Date	Lead Agency/Company	Description
Former Popping Plant (EPA, 2013a)	Summer 2011	EPA	Soil removal
Central Maintenance Building (CDM Smith, 2011)	Fall 2011	EPA	Interior cleaning of areas impacted by land owner removal of asbestos-containing roof materials
Port Authority Building (CDM Offices; EPA 2012a)	Spring 2012	EPA	Soil removal associated with revegetation demonstration plot/
Former Nursery Area (EPA, 2012b)	Summer 2012	EPA	Soil removal
Central Maintenance Building (EPA, 2012c)	Fall 2012	EPA	Removal of vermiculite-containing insulation and interior cleaning.
Former Tree Nursery (EPA, 2013b)	Spring 2013	EPA	Soil Removal

Source: CDM (2007) OU5, Final Data Summary Report – October 16, 200; CDM (2012) Summary Report Memorandum and various Removal and Restoration Completion Forms (EPA or CDM, 2010-2013).

TABLE 3-1
Sampling Events at OU5

Location	Date	Investigation Description	Media Collected and Analyzed	Reason for Selecting Sample Location
Former Nursery	May 2002	Phase I Investigation	Dust	Investigative
OU5 Site-wide	September/ October 2002	Contaminant Screening Study (including building inspections)	Air, personal Air, stationary Dust Soil	Non-discriminatory grid based sampling
MotoX Track	May 2004	Soil sampling	Soil	High use area
Central Maintenance Building	April/May, August 2004	Pre-design inspection; soil, dust, and bulk insulation sampling	Soil Dust Bulk	Building contains vermiculite based materials
Proposed Demolition Derby Area	July 2004	Soil sampling	Soil	High use area
Former Nursery	June 2005	Soil and air sampling to correlate soil contamination with airborn fibers.	Air, personal Air, stationary Soil	Location was suspected to have vermiculite in soils and was therefore a suitable location.
OU5 Monitoring Station	October 2006 to September 2007	Libby ambient air monitoring	Air, stationary	Aimed to determine general background asbestos concentration levels at site
OU5 Site-wide	October 2007	Soil data gap sampling	Soil	Collect samples from areas not previously investigated.
Wood Chip/Waste Bark Piles	October 2007	Wood chip/waste bark pile sampling; outdoor worker activity-based sampling	Air, personal Soil Waste bark Wood chips	Waste bark stored on site may contain asbestos and traveled to site

Note: Excludes worker air samples collected as part of OSHA requirements that were analyzed by AHERA

Source: Based on a download of the Libby2DB performed 12/9/09

TABLE 3-1 (continued)
Sampling Events at OU5

Location	Date	Investigation Description	Media Collected and Analyzed	Reason for Selecting Sample Location
Various OU5 Buildings	November 2007 to January 2008	Indoor worker activity-based sampling	Air, personal Air, stationary Dust	Estimate LA exposure to workers
OU5 Site-wide	June/July 2008	Soil data gap addendum sampling	Air, personal Soil	Collect samples from areas not previously investigated.
MotoX Track	September 2008	Outdoor recreational activity-based sampling	Air, personal Air, stationary Soil	Estimate LA exposure to recreational users
Bicycle & Hiking Trail near Libby Creek	September 2008	Outdoor recreational activity-based sampling	Air, personal	Estimate LA exposure to recreational users
OU5 Site-wide	September/ October 2008	Outdoor worker activity-based sampling	Air, personal Soil Vegetation	Estimate LA exposure to workers
Landfarm	October 2008	Landfarm soil sampling	Soil	Area of Groundwater Superfund Site not previously sampled
OU5 Re-development Zones	April 2009	Re-development soil sampling	Soil	EPA requested to do re-development plans
Libby Creek Driveway	April 2009	Pre-design inspection; soil	Soil	EPA requested to do re-development plans
Wood Chip Piles	August 2011	Outdoor activity-based sampling	Air, personal	Estimate LA exposure to individuals who distrurb wood chips.
Proposed fishing pond location	June 2012	Pre-design soil sampling	Soil	Assessment prior to design/construction of proposed fishing pond.

Note: Excludes worker air samples collected as part of OSHA requirements that were analyzed by AHERA

Source: Based on a download of the Libby2DB performed 12/9/09; CDM Smith 2012 and EPA 2013b

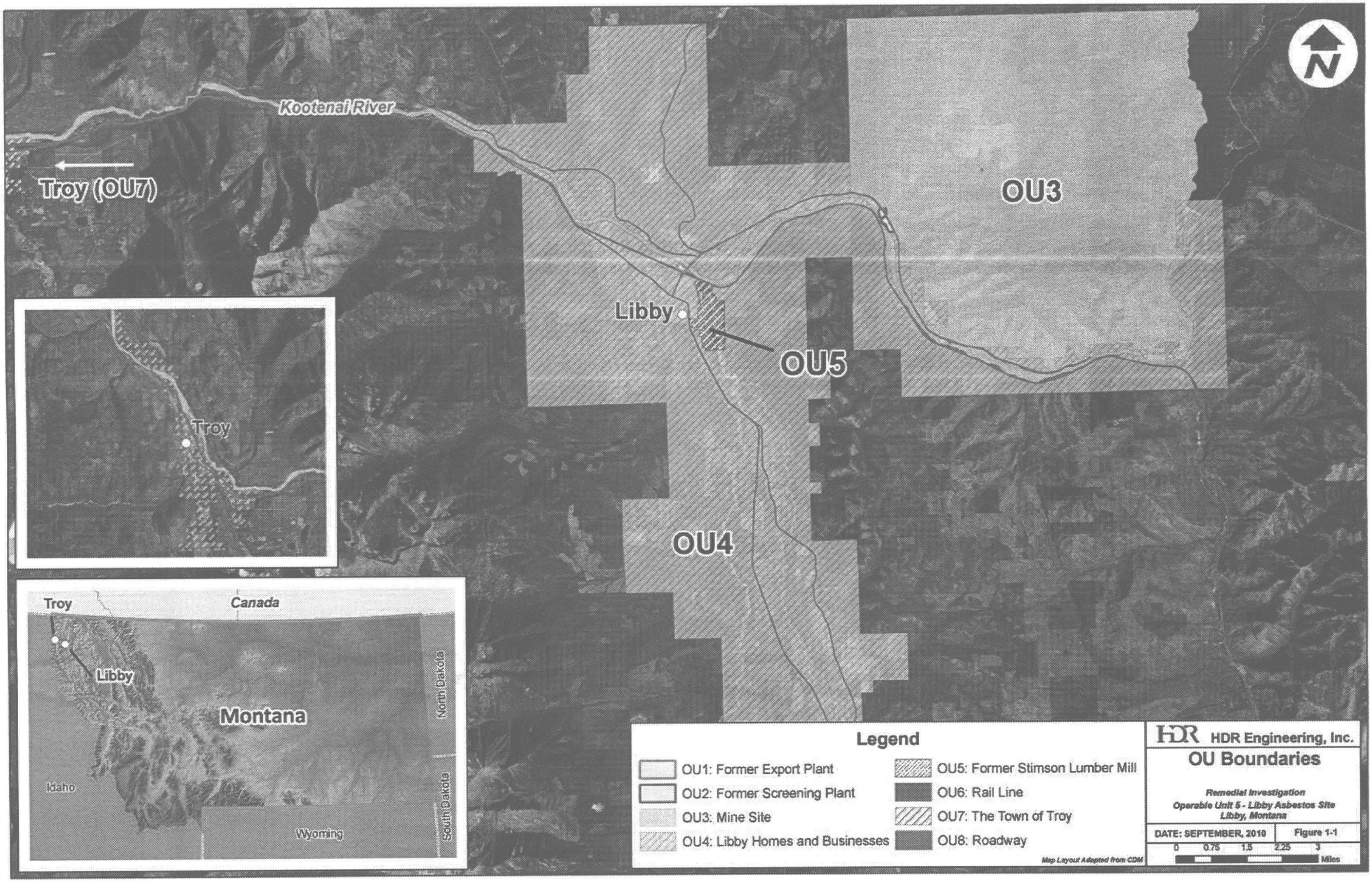
TABLE 3-2

Visible Vermiculite Inspection Scores and Selected Locations for Outdoor Worker ABS

Area	Visible Inspection Results				Score	Category
	None	Low	Med	High		
1	30				0.00	None
2	30				0.00	None
3	28	2			0.07	Low
4	28	2			0.07	Low
5	26	4			0.13	Medium
6	26	4			0.13	Medium
7	21	8	1		0.37	High
8	6	20	3	1	1.30	High

See figure 3.2 for ABS Area Locations

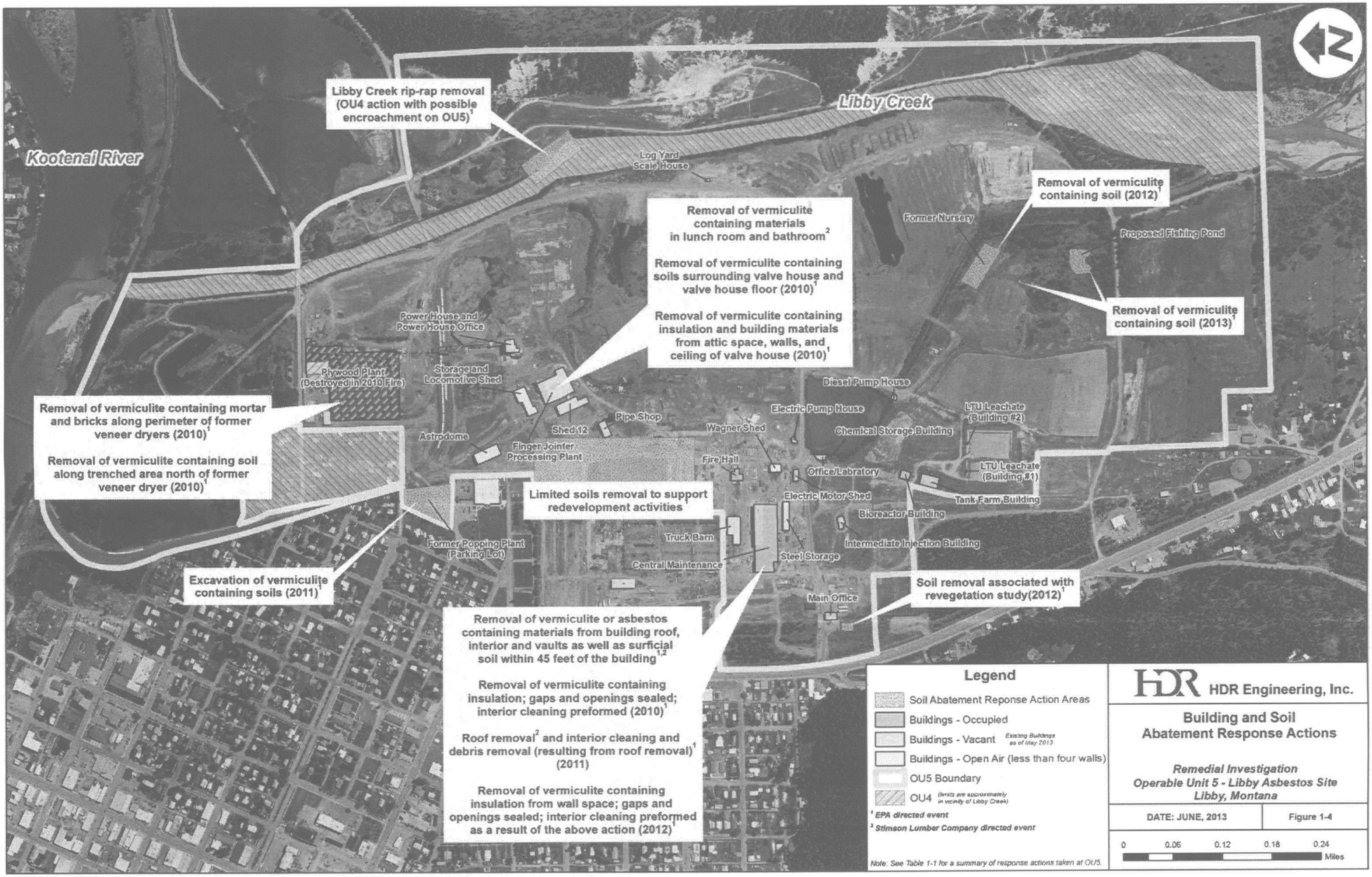
Figures



Kootenai River
Troy (OU7)
OU3
Libby
OU5
OU4
Troy
Troy
Canada
Libby
Montana
Idaho
Wyoming
North Dakota
South Dakota
Legend
OU1: Former Export Plant
OU2: Former Screening Plant
OU3: Mine Site
OU4: Libby Homes and Businesses
OU5: Former Stimson Lumber Mill
OU6: Rail Line
OU7: The Town of Troy
OU8: Roadway
Map Layout Adapted from CDM
HDR Engineering, Inc.
OU Boundaries
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: SEPTEMBER, 2010
Figure 1-1
0 0.75 1.5 2.25 3
Miles

37
Kootenai River
N
OU4
City of Libby
Libby Creek
OU5
Groundwater Superfund Site
2
HDR Engineering, Inc.
Libby Groundwater Superfund Site
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: SEPTEMBER, 2010
Figure 1-2
0 0.075 0.15 0.225 0.3
Miles

N
Kootenai River
Libby Creek
Plywood Plant (Destroyed in 2010 Fire)
Astrodome
Power House and Power House Office
Finger Jointer Processing Plant
Storage and Locomotive Shed
Pipe Shop
Shed 12
Log Yard Scale House (Occupied)
Truck Barn
Fire Hall
Central Maintenance
Wagner Shed
Electric Pump House
Steel Storage
Main Office
Electric Motor Shed
Office/Labratory
Chemical Storage Building
Intermediate Injection Building
Diesel Pump House
Bioreactor Building
Tank Farm Building
LTU Leachate (Building #1) (Vacant)
LTU Leachate (Building #2) (Vacant)
Legend
Bike Path (Unpaved or Partially Paved)
Bike Path (Paved, as of Sept. '10)
Storm Water Containment and Waste Water Lagoon Area
Waste Bark Piles Debris
Approved Waste Bark Disposal Area
MotoX Track
Libby Groundwater Superfund Site
OU5 Boundary
OU4 (limits are approximately in vicinity of Libby Creek)
Surface Water
Buildings - Occupied
Buildings - Vacant (Existing Buildings as of May 2013)
Buildings - Open Air (less than four walls)
Railroad Spur
Former Popping Plant
Lumber Yard
Former Champion Int. Tree Nursery
Log Storage Area
Southwest Area
Note: Some map objects adapted from CDM
HDR HDR Engineering, Inc.
OU5 Land Uses and Building Locations
Focused Feasibility Study
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: MAY, 2013
Figure 1-3
0 0.075 0.15 0.225 0.3
Miles


Kootenai River
Libby Creek
Libby Creek rip-rap removal (OU4 action with possible encroachment on OU5)[1]
Log Yard Scale House
Removal of vermiculite containing materials in lunch room and bathroom[2]
Removal of vermiculite containing soils surrounding valve house and valve house floor (2010)[1]
Removal of vermiculite containing insulation and building materials from attic space, walls, and ceiling of valve house (2010)[1]
Former Nursery
Removal of vermiculite containing soil (2012)[1]
Proposed Fishing Pond
Removal of vermiculite containing soil (2013)[1]
Power House and Power House Office
Storage and Locomotive Shed
Plywood Plant (Destroyed in 2010 Fire)
Removal of vermiculite containing mortar and bricks along perimeter of former veneer dryers (2010)[1]
Removal of vermiculite containing soil along trenched area north of former veneer dryer (2010)[1]
Astrodome
Finger Jointer Processing Plant
Shed 12
Pipe Shop
Diesel Pump House
Electric Pump House
Wagner Shed
Chemical Storage Building
LTU Leachate (Building #2)
LTU Leachate (Building #1)
Fire Hall
Office/Labratory
Tank Farm Building
Electric Motor Shed
Bioreactor Building
Limited soils removal to support redevelopment activities[1]
Truck Barn
Intermediate Injection Building
Steel Storage
Central Maintenance
Former Popping Plant (Parking Lot)
Excavation of vermiculite containing soils (2011)[1]
Main Office
Soil removal associated with revegetation study(2012)[1]
Removal of vermiculite or asbestos containing materials from building roof, interior and vaults as well as surficial soil within 45 feet of the building[1,2]
Removal of vermiculite containing insulation; gaps and openings sealed; interior cleaning preformed (2010)[1]
Roof removal[2] and interior cleaning and debris removal (resulting from roof removal)[1] (2011)
Removal of vermiculite containing insulation from wall space; gaps and openings sealed; interior cleaning preformed as a result of the above action (2012)[1]
Legend
Soil Abatement Reponse Action Areas
Buildings - Occupied
Buildings - Vacant
Existing Buildings as of May 2013
Buildings - Open Air (less than four walls)
OU5 Boundary
OU4 (limits are approximately in vicinity of Libby Creek)
[1] EPA directed event
[2] Stimson Lumber Company directed event
Note: See Table 1-1 for a summary of response actions taken at OU5.
HDR Engineering, Inc.
Building and Soil Abatement Response Actions
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: JUNE, 2013
Figure 1-4
0
0.06
0.12
0.18
0.24
Miles

Legend

- Surface Soil Sampling Locations
- Bike Path (Unpaved or Partially Paved)
- Bike Path (Paved, as of Sept. '10)
- Storm Water Containment and Waste Water Lagoon Area
- Waste Bark Piles Debris
- Approved Waste Bark Disposal Area
- MotoX Track
- Libby Groundwater Superfund Site
- Worker ABS Areas
- OU5 Boundary
- OU4 (limits are approximately in vicinity of Libby Creek)
- Surface Water
- Buildings - Occupied
- Buildings - Vacant (Existing Buildings as of May 2013)
- Buildings - Open Air (less than four walls)
- Railroad Spur
- Former Popping Plant
- Lumber Yard
- Former Champion Int. Tree Nursery
- Log Storage Area
- Southwest Area

HDR Engineering, Inc.

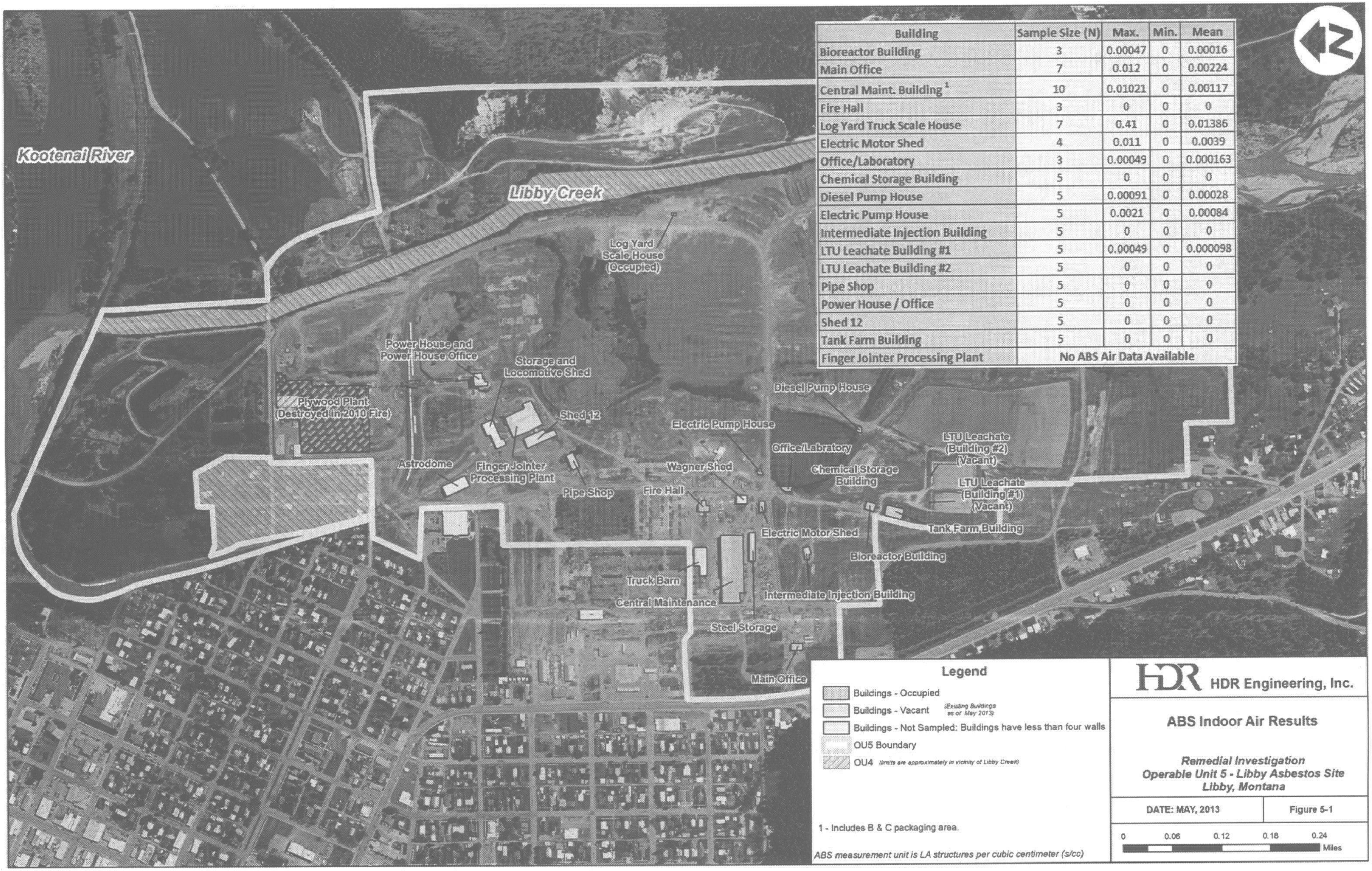
Surface Soil Sampling Locations

Remedial Investigation

Operable Unit 5 - Libby Asbestos Site
Libby, Montana

DATE: MAY, 2013	Figure 3-1

0 0.075 0.15 0.225 0.3 Miles



Building	Sample Size (N)	Max.	Min.	Mean
Bioreactor Building	3	0.00047	0	0.00016
Main Office	7	0.012	0	0.00224
Central Maint. Building [1]	10	0.01021	0	0.00117
Fire Hall	3	0	0	0
Log Yard Truck Scale House	7	0.41	0	0.01386
Electric Motor Shed	4	0.011	0	0.0039
Office/Laboratory	3	0.00049	0	0.000163
Chemical Storage Building	5	0	0	0
Diesel Pump House	5	0.00091	0	0.00028
Electric Pump House	5	0.0021	0	0.00084
Intermediate Injection Building	5	0	0	0
LTU Leachate Building #1	5	0.00049	0	0.000098
LTU Leachate Building #2	5	0	0	0
Pipe Shop	5	0	0	0
Power House / Office	5	0	0	0
Shed 12	5	0	0	0
Tank Farm Building	5	0	0	0
Finger Jointer Processing Plant	No ABS Air Data Available			

Legend

- Buildings - Occupied
- Buildings - Vacant (Existing Buildings as of May 2013)
- Buildings - Not Sampled: Buildings have less than four walls
- OU5 Boundary
- OU4 (limits are approximately in vicinity of Libby Creek)

1 - Includes B & C packaging area.

ABS measurement unit is LA structures per cubic centimeter (s/cc)

HDR Engineering, Inc.

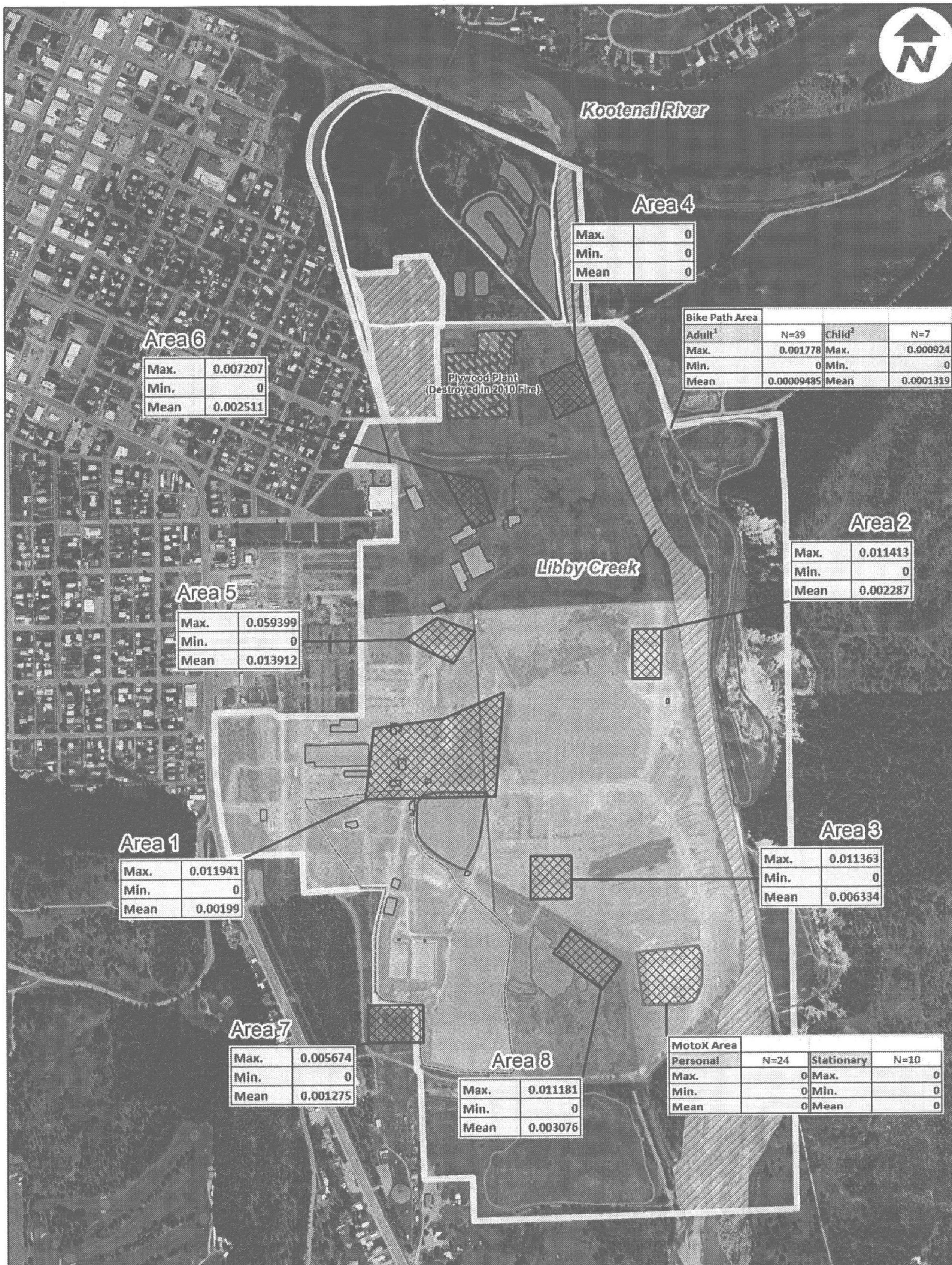
ABS Indoor Air Results

Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana

DATE: MAY, 2013

Figure 5-1

0 0.06 0.12 0.18 0.24 Miles



ABS Outdoor Air Testing Sites*

- Bike Path (Unpaved or Partially Paved)
- Bike Path (Paved, as of Sept. '10)
- Worker ABS Areas (N = 6)
- MotoX Track
- Storm Water Containment and Waste Water Lagoon Area
- Waste Bark Piles Debris
- Approved Waste Bark Disposal Area
- Libby Groundwater Superfund Site
- OU5 Boundary
- OU4 (limits are approximately in vicinity of Libby Creek)
- Buildings (Existing Buildings as of May 2013)
- Surface Water
- Railroad Spur
- Former Popping Plant
- Lumber Yard
- Former Champion Int. Tree Nursery
- Log Storage Area
- Southwest Area

HDR Engineering, Inc.

ABS Outdoor Air Results

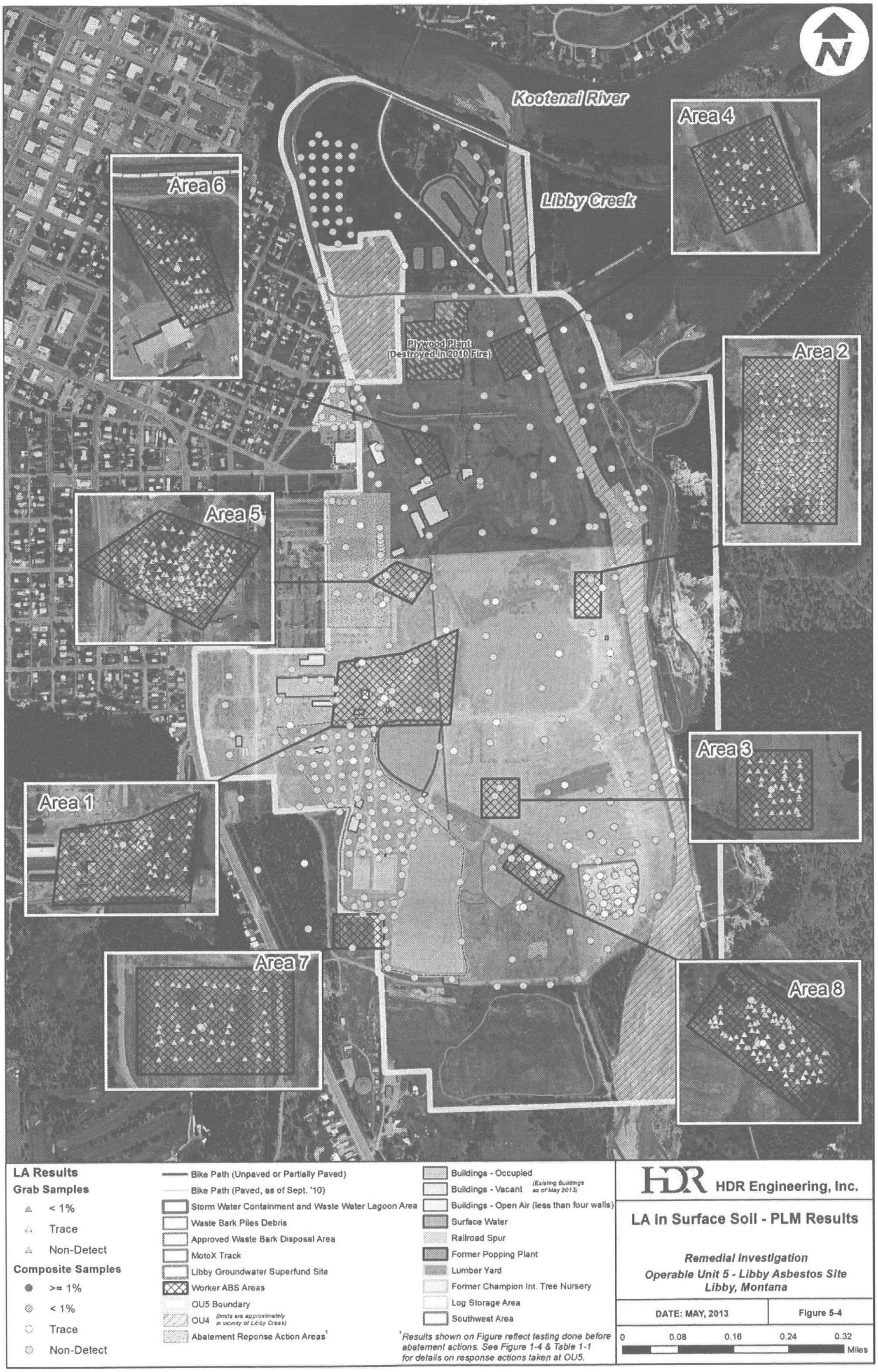
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana

DATE: MAY, 2013 | Figure 5-2

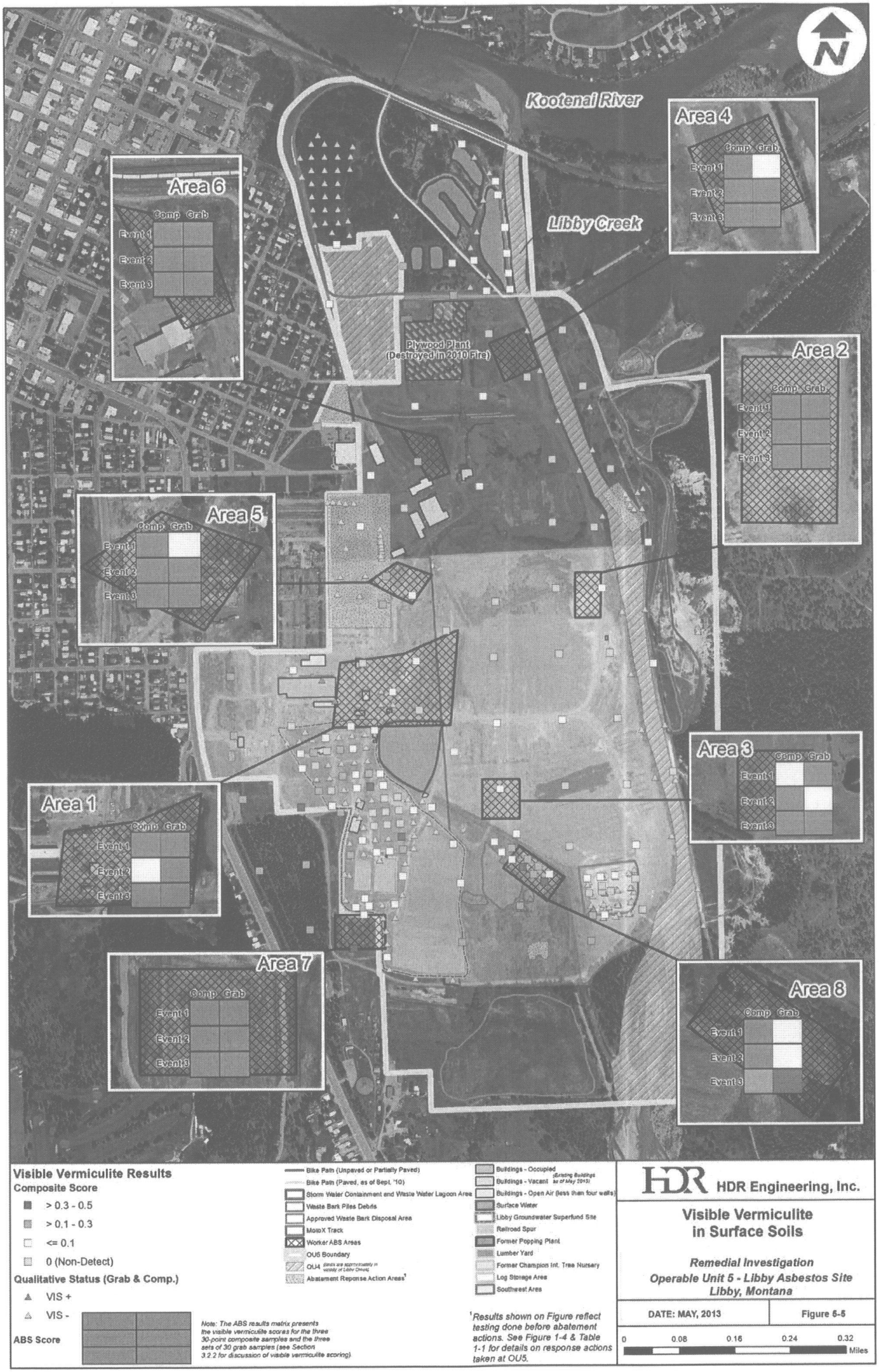
0 0.08 0.16 0.24 0.32 Miles

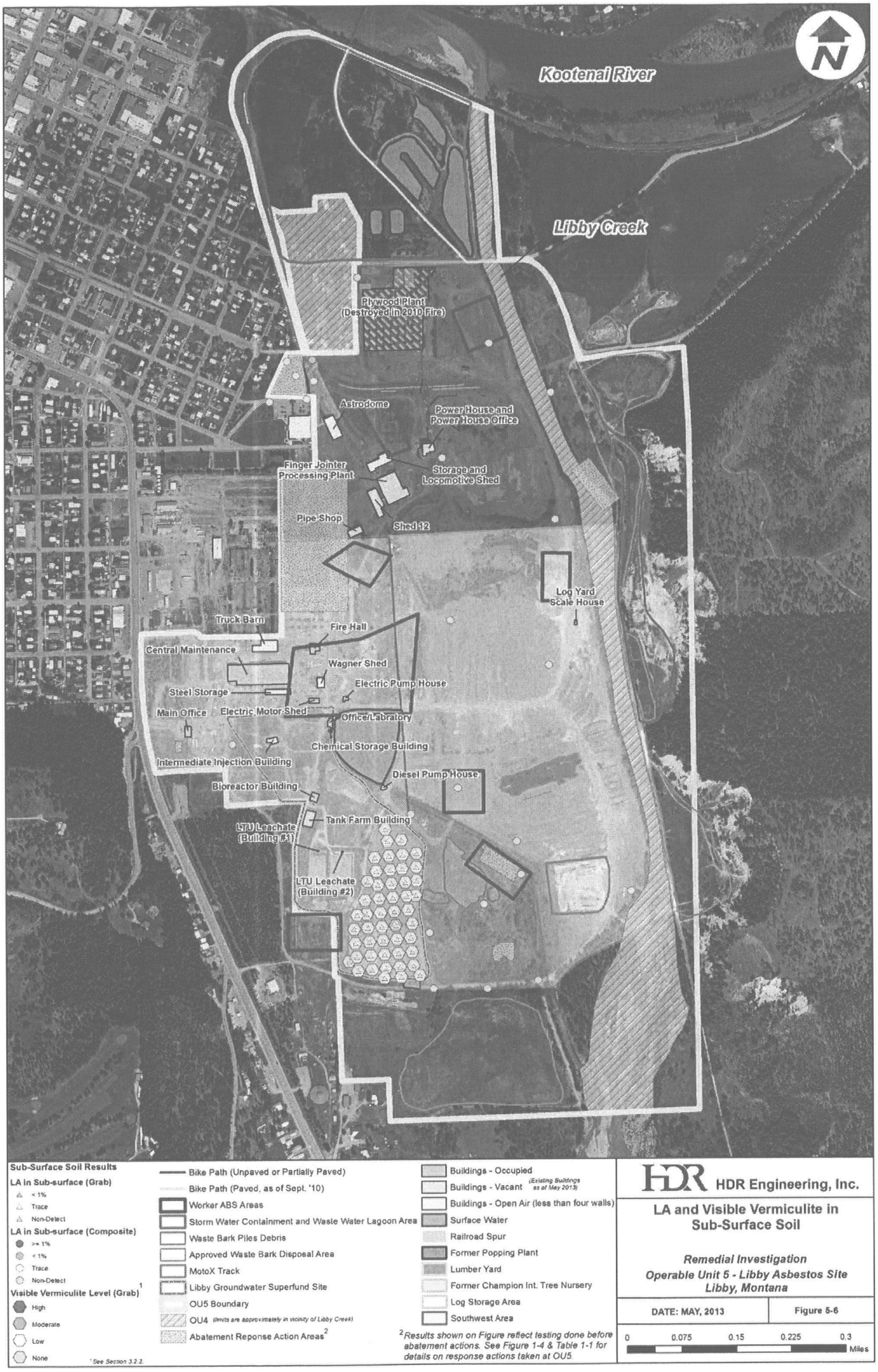
*Note: * ABS Measurement Unit: LA structures per cubic centimeter (s/cc)*
[1] "Adult" personal air samples were collected while riding a bicycle on both the paved and unpaved portions of the bicycle path.
[2] "Child" personal air samples were collected via an air monitor placed in a trailer attachment to a bicycle. "Child" personal air samples were collected only on the paved portion of the bike path.

Kootenai River
Libby Creek
Log Yard
Scale House
Power House and
Power House Office
Storage and Locomotive Shed
Diesel Pump House
Plywood Plant
(Destroyed in 2010 Fire)
Pipe Shop
Wagner Shed
Electric Pump House
Astrodome
Shed 12
Finger Jointer
Processing Plant
Fire Hall
Lumber Kilns
Electric Motor Shed
Truck Barn
Steel Storage
Central Maintenance
Main Office
Legend
LA in Dust
Non-detect
Less than
5,000 s/cm²
Greater than
5,000 s/cm²
OU5 Boundary
OU4
Adapted from CDM
HDR Engineering, Inc.
LA in Indoor Dust
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: SEPTEMBER, 2010
Figure 5-3
0
0.06
0.12
0.18
0.24
Miles



N
Kootenai River
Libby Creek
Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Area 8
Plywood Plant
(Destroyed in 2010 Fire)
LA Results
Grab Samples
< 1%
Trace
Non-Detect
Composite Samples
>= 1%
< 1%
Trace
Non-Detect
Bike Path (Unpaved or Partially Paved)
Bike Path (Paved, as of Sept. '10)
Storm Water Containment and Waste Water Lagoon Area
Waste Bark Piles Debris
Approved Waste Bark Disposal Area
MotoX Track
Libby Groundwater Superfund Site
Worker ABS Areas
OU5 Boundary
OU4 (limits are approximately in vicinity of Libby Creek)
Abatement Reponse Action Areas[1]
Buildings - Occupied
Buildings - Vacant (Existing Buildings as of May 2013)
Buildings - Open Air (less than four walls)
Surface Water
Railroad Spur
Former Popping Plant
Lumber Yard
Former Champion Int. Tree Nursery
Log Storage Area
Southwest Area
[1]Results shown on Figure reflect testing done before abatement actions. See Figure 1-4 & Table 1-1 for details on response actions taken at OU5.
HDR Engineering, Inc.
LA in Surface Soil - PLM Results
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: MAY, 2013
Figure 5-4
0
0.08
0.16
0.24
0.32
Miles


N
Kootenai River
Libby Creek
Plywood Plant
(Destroyed in 2010 Fire)
Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Area 8
Comp Grab
Event 1
Event 2
Event 3
Visible Vermiculite Results
Composite Score
> 0.3 - 0.5
> 0.1 - 0.3
<= 0.1
0 (Non-Detect)
Qualitative Status (Grab & Comp.)
VIS +
VIS -
ABS Score
Note: The ABS results matrix presents the visible vermiculite scores for the three 30-point composite samples and the three sets of 30 grab samples (see Section 3.2.2 for discussion of visible vermiculite scoring)
Bike Path (Unpaved or Partially Paved)
Bike Path (Paved, as of Sept. '10)
Storm Water Containment and Waste Water Lagoon Area
Waste Bark Piles Debris
Approved Waste Bark Disposal Area
MotoX Track
Worker ABS Areas
OU5 Boundary
OU4
Abatement Reponse Action Areas[1]
Buildings - Occupied
Buildings - Vacant
(Existing Buildings as of May 2013)
Buildings - Open Air (less than four walls)
Surface Water
Libby Groundwater Superfund Site
Railroad Spur
Former Popping Plant
Lumber Yard
Former Champion Int. Tree Nursery
Log Storage Area
Southwest Area
[1]Results shown on Figure reflect testing done before abatement actions. See Figure 1-4 & Table 1-1 for details on response actions taken at OU5.
HDR Engineering, Inc.
Visible Vermiculite
in Surface Soils
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: MAY, 2013
Figure 5-5
0
0.08
0.16
0.24
0.32
Miles



N
Kootenai River
Libby Creek
Plywood Plant
(Destroyed in 2010 Fire)
Astrodome
Power House and
Power House Office
Finger Jointer
Processing Plant
Storage and
Locomotive Shed
Pipe Shop
Shed 12
Log Yard
Scale House
Truck Barn
Fire Hall
Central Maintenance
Wagner Shed
Electric Pump House
Steel Storage
Main Office
Electric Motor Shed
Office/Labratory
Chemical Storage Building
Intermediate Injection Building
Diesel Pump House
Bioreactor Building
Tank Farm Building
LTU Leachate
(Building #1)
LTU Leachate
(Building #2)
Sub-Surface Soil Results
LA in Sub-surface (Grab)
< 1%
Trace
Non-Detect
LA in Sub-surface (Composite)
>= 1%
< 1%
Trace
Non-Detect
Visible Vermiculite Level (Grab)[1]
High
Moderate
Low
None
[1] See Section 3.2.2.
Bike Path (Unpaved or Partially Paved)
Bike Path (Paved, as of Sept. '10)
Worker ABS Areas
Storm Water Containment and Waste Water Lagoon Area
Waste Bark Piles Debris
Approved Waste Bark Disposal Area
MotoX Track
Libby Groundwater Superfund Site
OU5 Boundary
OU4 (limits are approximately in vicinity of Libby Creek)
Abatement Reponse Action Areas[2]
Buildings - Occupied
Buildings - Vacant (Existing Buildings as of May 2013)
Buildings - Open Air (less than four walls)
Surface Water
Railroad Spur
Former Popping Plant
Lumber Yard
Former Champion Int. Tree Nursery
Log Storage Area
Southwest Area
[2] Results shown on Figure reflect testing done before abatement actions. See Figure 1-4 & Table 1-1 for details on response actions taken at OU5.
HDR Engineering, Inc.
LA and Visible Vermiculite in Sub-Surface Soil
Remedial Investigation
Operable Unit 5 - Libby Asbestos Site
Libby, Montana
DATE: MAY, 2013
Figure 5-6
0
0.075
0.15
0.225
0.3
Miles

Appendices